NOT MEASUREMENT SENSITIVE

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DEPARTMENT OF DEFENSE
INTERFACE STANDARD

INTEROPERABILITY STANDARD
FOR
5-kHz UHF DAMA TERMINAL WAVEFORM

AMSC N/A

FSA TCSS

FOREWORD

1. This standard is approved for use by all Departments and Agencies of the Department of Defense (DoD).

2. In accordance with DoD Instruction 4630.8, it is DoD policy that all joint and combined operations be supported by compatible, interoperable, and integrated command, control, communications, and intelligence (C3I) systems. Furthermore, all C3I systems developed for use by U.S. forces are considered for joint use. The Director, Defense Information Systems Agency (DISA), serves as the DoD single point of contact for developing information technology standards to achieve interoperability and compatibility. All C3I systems and equipment shall conform to technical and procedural standards for compatibility and interoperability, as developed or recommended by DISA.

3. MIL-STDs in the 188 series (MIL-STD-188-XXX) address telecommunications design parameters based on commercial-off-the-shelf (COTS) technologies and are to be used in all new DoD systems and equipment, or major upgrades thereto, to ensure interoperability. The MIL-STD-188 series is subdivided into a MIL-STD-188-100 series, covering common standards for tactical and long-haul communications; a MIL-STD-188-200 series, covering standards for tactical communications only; and a MIL-STD-188-300 series, covering standards for long-haul communications only. Emphasis is being placed on the development of common standards for tactical and long-haul communications (the MIL-STD-188-100 series). The MIL-STD-188 series may be based on, or make reference to, American National Standards Institute (ANSI) standards, International Telecommunications Union - Telecommunication Standardization Sector (ITU-T) recommendations, International Standards Organization (ISO) standards, North Atlantic Treaty Organization (NATO) standardization agreements (STANAG), and other standards, wherever applicable.

4. This standard complies with Joint Staff direction that a new standard be developed to define all technical characteristics essential for interoperability and performance of satellite communications (SATCOM) terminals that use 5-kHz ultra high frequency (UHF) demand-assigned multiple access (DAMA) SATCOM transponder channels. This standard defines mandatory system parameters for planning, engineering, procuring, and using UHF SATCOM terminals in joint operations.

5. Beneficial comments and any pertinent data which may be of use in improving this standard should be addressed to:

Defense Information Systems Agency
Joint Interoperability and Engineering Organization
ATTN: JEBBC
Fort Monmouth, NJ 07703-5613

by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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1. SCOPE

1.1 Purpose. This standard establishes mandatory requirements applicable to satellite communications (SATCOM) terminals required to operate in demand-assigned multiple access (DAMA) mode over 5-kHz ultra high frequency (UHF) SATCOM channels. The requirements specified herein represent the minimum set required for interoperability; such requirements may be exceeded by equipment developers to satisfy specific service requirements, provided that interoperability is maintained. For example, the incorporation of additional standard and nonstandard interfaces is not precluded.

1.2 Scope. This standard is mandatory within the Department of Defense (DoD) and shall be invoked by equipment specifications for all future terminals required to operate in the DAMA mode over 5-kHz UHF SATCOM channels.

1.3 Application guidance. In this MIL-STD, the word *shall* identifies mandatory system standards. The word *should* identifies design objectives that are desirable but not mandatory. The terms *system standard* and *design objective* are defined in FED-STD-1037.

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2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3, 4, and 5 of this standard, whether or not they are listed.

2.2 Government documents

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplements thereto, cited in the solicitation.

SPECIFICATIONS

MILITARY

MIL-C-28883	*Military Specification for the Advanced Narrowband Digital Voice Terminal (ANDVT) Set, AN/USC-43(V)*

(Unless otherwise indicated, copies of the above specifications are available from Commander, Space and Naval Warfare Systems Command, Washington, D.C., 20363-5100.)

STANDARDS

FEDERAL

FED-STD-1037	*Glossary of Telecommunication Terms*

DEPARTMENT OF DEFENSE

MIL-STD-188-181	*Interoperability Standard for Single-access 5-kHz and 25-kHz UHF Satellite Communications Channels*
MIL-STD-188-183	*Interoperability Standard for 25-kHz UHF TDMA/DAMA Terminal Waveform*

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

NATIONAL SECURITY AGENCY (NSA)

NSA NO. 82-2	*NSA Performance and Interface Specification for TSEC/KG-84A, General Purpose Encryption Equipment (GPEE)*
NSA NO. 87-01	*KGV-11 and KGV-11(E2) Interface Specification*
NSA NO. 88-4	*National Security Agency Interface Specification for THORNTON COMSEC/TRANSEC Integrated Circuit (CTIC)*

(Copies of NSA documents are available from the Director, National Security Agency, ATTN: V31, 9800 Savage Road, Fort George G. Meade, MD 20755-6000.)

2.3 Order of precedence. In the event of a conflict between this document and the references cited herein, the text of this document takes precedence. Nothing in this standard, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. DEFINITIONS

3.1 Terms. Terms not listed below are as defined in FED-STD-1037.

3.1.1 Access. The ability, permission, or liberty to communicate with, or make use of, any system resource.

3.1.2 Acknowledgment. A message from the addressee indicating that information has been received without error.

3.1.3 Acquisition back-off number. A number used by the terminal in the algorithm to reduce the possibility of conflicting transmissions during the initial ranging of terminals.

3.1.4 Active ranging. The transmission and subsequent reception of a burst signal used for estimating the range to a satellite.

3.1.5 Active service. A service that has been assigned communications resources and has not been torn down. Active services are either assigned or preempted.

3.1.6 Allocation. TDMA frame time apportioned by the PCC for a particular function.

3.1.7 Alternate channel controller. The control station function that monitors the channel and can assume control, either manually by operator action or automatically when it detects that the primary channel controller has failed.

3.1.8 Assigned-ROW time slot. A ROW segment time slot that a PCC assigns to a specific terminal for the terminal's sole use. The assignment is made by the PCC when the terminal is required to respond to a FOW, such as when the PCC transmits a FOW requesting a network status message be transmitted by the terminal.

3.1.9 Assigned service. A service being assigned communications resources.

3.1.10 Automatic frequency change. A terminal capability to automatically switch to and operate on another 5- or 25-kHz DASA or DAMA channel upon receipt of a FOW directing such a change. This capability requires the change to be accomplished within 8.96...seconds for switching to a DASA channel, 90 seconds for switching to another DAMA channel (5- or 25-kHz), and 90 seconds for switching from a DASA channel to a DAMA channel. The 90 second switching time from a DASA to a DAMA channel applies when assigned time on DASA channel expires.

3.1.11 Blocked service. A queued service held from scheduling, awaiting (1) the availability of participating terminals busy with other services, or (2) the completion of setting up the path for a multiple-hop service.

3.1.12 Building block. A fundamental unit of channel time used in determining time within a frame. Used in the assignment of channel resources.

3.1.13 Burst. A time-limited transmission composed of a synchronization preamble and a finite-length data stream.

3.1.14 Burst code. A combination of modulation rate, coding rate, and (for message services) maximum burst size.

3.1.15 Channel controller. A generic term that relates to either a primary or alternate controller.

3.1.16 Channel resources. The available time, bandwidth, and power of a channel.

3.1.17 Circuit burst kind (CBK). A field that identifies the type of burst being transmitted during a circuit service.

3.1.18 Circuit service. Channel resource assignments in each frame that are dedicated for use by participating members for duration of the assignment.

3.1.19 Connected. The configuration of a channel controller in which connectivity to adjacent satellite footprints by relay is available.

3.1.20 Contention-ROW time slot. A ROW segment time slot available for use by any terminal that has achieved downlink acquisition. The possibility exists that transmissions from multiple terminals will occur in the same time slot.

3.1.21 Control station. The equipment and software that performs resource management, channel control, and external interface functions in two adjacent satellite coverage areas.

3.1.22 Data block. A quantity of user data (224 bits) used in integer multiples within message-service packets.

3.1.23 Demand assigned single access (DASA). An access scheme in which a SATCOM channel is assigned for single access through the DAMA control system in accordance with demand.

3.1.24 Destination terminal. The terminal addressee of a communication.

3.1.25 Downlink acquisition. Condition during initial acquisition of the waveform, when the terminal or a noncontrolling CC receives a correct FOW burst.

3.1.26 Field. A specific portion of a burst.

3.1.27 Flush bits. Bits added to a data field prior to encoding to provide proper convolutional encoder operation.

3.1.28 Forward orderwire (FOW). The orderwire used for transmitting control and status information from a primary channel controller to terminals or alternate channel controller.

3.1.29 Frame. A unit of time on the channel. A frame is 8.96...seconds long and consists of 1024 building blocks which are grouped into segments for waveform overhead and user-to-user communications.

3.1.30 Full-duplex. (1) Communications that occur in both directions (transmit and receive) within one frame. (2) A characteristic that signifies the terminal's capability to simultaneously receive and transmit rf signals.

3.1.31 Global. A network configuration in which relays are present and data may be routed to a network on another satellite channel.

3.1.32 Guard list. A set of addresses for which a terminal receives services.

3.1.33 Guard time. Unused time interval within a frame that prevents overlap of transmissions that could occur due to timing differences between transmitting terminals.

3.1.34 Half-duplex. A characteristic that allows the terminal to receive and transmit signals, but not both at the same time.

3.1.35 Indicator. A symbol, flag, or signal that serves to identify a specific state or item.

3.1.36 I/O rate. The rate, in units of bits per second (bps), at which bits are sent to or received from an I/O device.

3.1.37 Local. (1) Operations within a channel or group of channels in a single footprint controlled by one PCC. (2) Initiations by an equipment operator.

3.1.38 Local footprint. The satellite coverage area of a PCC and the terminals operating under its control.

3.1.39 Message service. A service that provides resources for transmitting messages, using a packet-oriented protocol.

3.1.40 Modulation rate. The rate at which information is transferred across a satellite channel, in units of symbols per second (sps).

3.1.41 Multiple-channel. The network capability of automatically switching from channel to channel within a single satellite footprint for transmit and receive services when commanded by the PCC.

3.1.42 Multiple hop. Operations that relay information between two or more satellite channels.

3.1.43 Node. A terminal or channel controller in a network.

3.1.44 Nonprocessed channel. A satellite transponder in which the receive signal is amplified and frequency translated but the digital signals are not reconstituted before retransmission.

3.1.45 Operator. The person who controls and operates a communications terminal or controller.

3.1.46 Orderwire. The portion of the DAMA frame used for transmission of management, control, and status information among the channel controllers and terminal users.

3.1.47 Packet. For message service, the information transmitted in one burst.

3.1.48 Passive ranging. A process by which a terminal determines signal propagation time to a satellite by means other than transmitting a ranging signal.

3.1.49 Pending service. A queued service that is not blocked but is awaiting availability of communications resources on the channel.

3.1.50 Preassigned service. A type of service whose channel allocation is scheduled and set up well in advance of being used.

3.1.51 Preempted service. A service that has been interrupted to allow for higher-precedence network activities.

3.1.52 Primary channel controller. The control station function that actively controls the DAMA channel.

3.1.53 Queued service. A service in the request queue at the PCC waiting to be assigned communications resources. Queued services are either blocked or pending.

3.1.54 Ranging. A process by which a terminal determines signal propagation time to a satellite to establish uplink timing. See *active ranging* and *passive ranging*.

3.1.55 Relay. A method of communications in which data is passed from one DAMA channel to another to achieve greater connectivity than that which is provided by the one channel.

3.1.56 Return orderwire (ROW). The orderwire used to transmit control and status information from network terminals to the channel controller and perform system support functions, including ranging.

3.1.57 Service. A specified set of information-transfer capabilities provided to a group of users by the DAMA system.

3.1.58 Source terminal. The terminal from which information is considered to originate.

3.1.59 Subnet. A group of terminals with a need for common communications that share a common address.

3.1.60 Teardown. Termination of an established communication.

3.1.61 Terminal. An equipment or function that originates or terminates communications traffic.

3.1.62 Time slot. A fraction of a TDMA frame allocated for a specific control function (FOW and ROW) or user communications.

3.1.63 Transmission mode. A terminal configuration (such as modulation rate or I/O rate) specified by the channel controller for a specific transmission.

3.1.64 Uplink acquisition. The status attained by a terminal or an ACC (1) after downlink acquisition is successful, and (2) upon correct reception of a ranging burst or determination of round-trip propagation time to the satellite by some other means. Uplink acquisition is lost if round-trip propagation time to the satellite is not known to within 12.604 ms.

3.1.65 Waveform. The combination of baseband signal structure, rf signal structure, and communications protocols that provides a framework within which coordinated communications can be effected.

3.2 Abbreviations and acronyms. The abbreviations and acronyms used in this standard are defined as follows:

A	signal amplitude
ACC	alternate channel controller
$a_i(t)$	in-phase data modulation signal
$a_q(t)$	quadrature data modulation signal
$a_m, \ldots, a_0$	data bits, 0 or 1
ANDVT	Advanced Narrowband Digital Voice Terminal
BER	bit error ratio
bps	bit per second
C2	command and control
CBK	circuit burst kind
CC	channel controller
C/N_o	carrier-power to noise-spectral-density ratio
COM	communications
COMSEC	communications security
CRC	cyclic redundancy check
CRS	contention ranging slots
CTIC	COMSEC/TRANSEC integrated circuit
CW	continuous wave
DAMA	demand assigned multiple access
DASA	demand assigned single access
dB	decibel
dB-Hz	decibel-hertz
dBW	decibels relative to 1 W
DISA	Defense Information Systems Agency
$D(x)$	data for which CRC is generated
DO	design objective
DoD	Department of Defense
DoDD	DoD directive
DoDISS	DoD Index of Specifications and Standards
E_b/N_o	signal-energy-per-bit to noise-spectral-density ratio
eirp	effective isotropically radiated power
FEC	forward error correction
FED-STD	federal standard
FIFO	first in, first out
FOW	forward orderwire

FSCS	Fleet Satellite Communications System
GPEE	general-purpose encryption equipment
G/T	antenna gain-to-noise temperature
G(x)	generating polynomial for CRC
Hz	hertz
I	in phase
I/O	input/output
JCS	Joint Chiefs of Staff
JIEO	Joint Interoperability and Engineering Organization
k	constraint length
kHz	kilohertz
LSB	least significant bit
MELP	Mixed Excitation Linear Prediction
MIL-STD	military standard
ms	millisecond
MSB	most significant bit
N	integer number
NSA	National Security Agency
OTAR	over-the-air rekeying
PCC	primary channel controller
Q	quadrature phase
rf	radio frequency
ROW	return orderwire
SATCOM	satellite communications
SOM	start-of-message
SOQPSK	shaped offset quadrature phase-shift keying
s(t)	transmit signal
sps	symbols per second
T	symbol period
TDMA	time-division multiple access
TRANSEC	transmission security
TSN	Time Slot Number
UHF	ultra high frequency

W	watt
ω_o	radian frequency, $2\pi \times$ frequency in hertz
x	unit delay
$\Phi(t)$	phase

4. GENERAL REQUIREMENTS

4.1 Communications system characteristics. The DAMA waveform defined in this MIL-STD provides for dynamic sharing among numerous users of one or more nonprocessed UHF SATCOM channels, in demand assigned single access (DASA) or demand assigned multiple access (DAMA) mode. Thousands of terminals, within the same satellite coverage area, may share the channels of one or more satellites. Real time network control is provided by a primary channel controller (PCC). The PCC receives and processes service requests and broadcasts assignments to terminals. Service requests are generated by terminals and sent to the PCC over the satellite path, using the return orderwire (ROW). The PCC responds with assignment of channel resources, using the forward orderwire (FOW). Below are highlighted the major benefits of this waveform:

a. Efficiency. The 5-kHz UHF DAMA waveform provides efficient handling of messages, as well as effective resource-sharing between voice and data communications. This waveform, when used on one 5-kHz channel, can support a message throughput of 900 messages per hour, with an average message length of 200 characters. Secure voice, operating at a 2400-bps rate, is supported, as are circuit and block message capabilities for handling digital data. In addition to demand assignment of channel resources, provisions exist for preassignment of channel resources.

b. Global communications. The control station performs the relay functions necessary to provide multiple-hop (global) communications. Control stations located in an area of overlapping satellite footprints can simultaneously access channels on satellites in the two areas. A terminal in one satellite footprint makes use of the automatic control station relay function to send information through one or more control stations to the desired destination terminal on another satellite channel.

4.2 Waveform description. The 5-kHz DAMA waveform provides communications among geographically dispersed terminals, using nonprocessed SATCOM channels. All signals within the channel bandwidth received at the satellite are translated in frequency and retransmitted with no digital processing. The communications signals consist of bursts of digitally encoded information. Transmission time and duration, as specified in this standard, depend on the nature of the information and are under PCC control.

4.2.1 General waveform structure. All channel time is divided into fixed intervals called *frames*. A frame time is further divided into 1024 increments known as *building blocks*. A single building block is 8.75 ms long. The building blocks are grouped into three segments, which vary in length and contain functionally related information that may be transmitted from more than one source. These segments are called the *FOW, ROW,* and *communications (COM) segments*. Segments are subdivided into one or more time slots that may be of various lengths. Figure 1 illustrates where the segments are located within the frame.

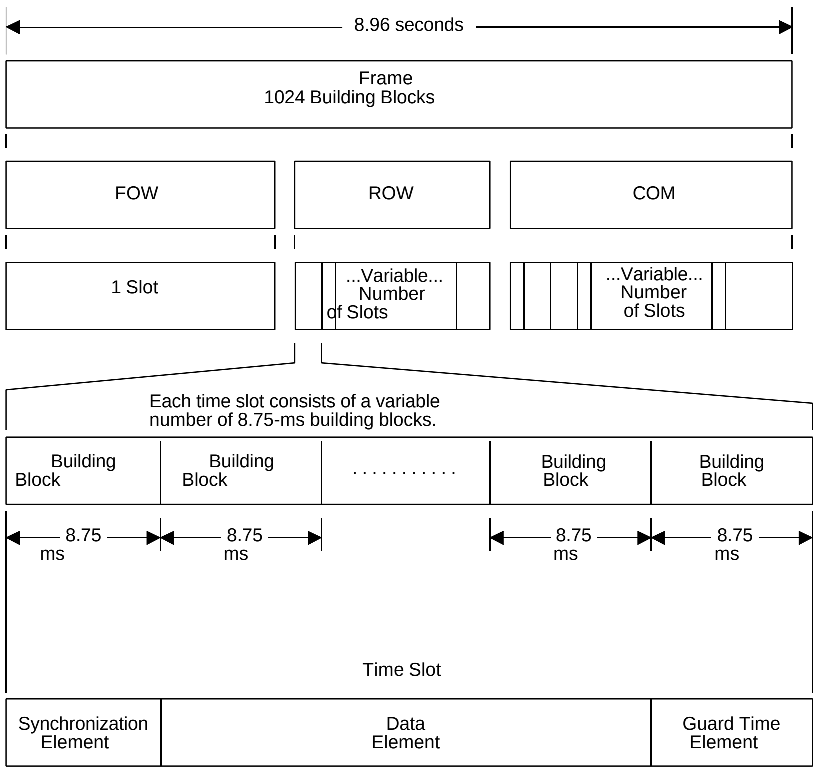


FIGURE 1. Frame format.

a. The FOW segment is composed of a single time slot. However, the ROW and COM segments may contain more than one time slot. A transmission from a single source [a terminal or a channel controller (CC)] occurs within a single time slot at a single modulation rate. However a time slot in the COM segment for a voice service, can contain multiple bursts per time slot as described in 5.4.2.2.4.2 b.

b. Each burst occurring within a time slot consists of two elements: (1) the synchronization element, a known signal that the receiver needs for carrier, bit, and data synchronization; and (2) the data element, in which the information is transmitted. There is guard time allocated for each time slot to avoid user-to-user interference which could result from transmit timing errors at individual terminals.

4.2.1.1 Waveform segment description. Channel resource control occurs by using the FOW and ROW messages (see Tables I and II), which are transmitted in the FOW and ROW segments, respectively. FOW messages originate at the PCC. ROW messages originate at a terminal or an ACC. User data is transmitted in the COM segment.

4.2.1.1.1 Forward orderwire segment. The FOW segment is located at the beginning of each frame. FOW transmissions contain information that enables terminals to acquire and maintain frame time and cryptographic synchronization with the PCC. They also contain DAMA control information for the next frame. The DAMA control information is provided in the form of system and directed messages. System messages broadcast system status and waveform restrictions to the terminals. Appendix A describes FOW system messages. Directed messages are used by the PCC to allocate channel resources, to respond to terminal login/logout requests, and to transmit other direct information necessary for managing the waveform. Table I lists all FOW directed messages; Appendix B describes these in detail.

4.2.1.1.2 Return orderwire segment. The ROW segment follows the FOW segment. ROW transmissions contain information from terminals and ACCs sent to the PCC or to themselves, as in the case of ranging. The ROW segment can have two types of time slots.

4.2.1.1.2.1 Return orderwire message time slots. These time slots are used to transmit ROW messages that contain control information. Table II lists all ROW messages. Appendix C describes these in detail.

4.2.1.1.2.2 Return orderwire ranging time slots. ROW-ranging time slots are used to make round-trip propagation time measurements for proper transmit timing. One or more contention-ranging time slot(s) are always at the beginning of the ROW segment. ROW-ranging time slots are longer than ROW-message time slots. ROW-ranging time slots provide additional guard time to ensure that a ranging burst does not interfere with transmissions.

4.2.1.1.3 Communications segment. Terminals communicate with other terminals, using assigned time slots within the COM segment. Two communications capabilities are supported: circuit service and message service. Circuit service provides time-slot assignment in each frame for fixed-rate digital voice and data communications among terminals and CCs. Message service provides more flexible and efficient use of channel resources (time) for fixed-length simplex data transfers.

TABLE I. FOW directed messages.

MESSAGE TYPE	NAME	DIRECTED TO TERMINAL*
0	FOW:Acknowledge Message	Yes
1	FOW:Acknowledge Blocks	Yes
2	FOW:Alternate Channel Controller Designate Response	No
3	FOW:Circuit Assignment	Yes
4	FOW:Circuit Setup Response	Yes
5	FOW:Circuit Teardown	Yes
6	FOW:Login Response	Yes
7	FOW:Logout Response	Yes
8	FOW:Message Acknowledgment	Yes
9	FOW:Message Assignment	Yes
10	FOW:Message Setup Response	Yes
11	FOW:Message Teardown	Yes
12	FOW:Multiple-Hop Begin Assignments Response	No
13	FOW:Multiple-Hop Circuit Assignment	Yes
14	FOW:Multiple-Hop Circuit Preemption Response	No
15	FOW:Multiple-Hop Service Teardown	Yes
16	FOW:Network Status	No
17	FOW:Network Status Response	No
18	FOW:Null Assignment	Yes
19	FOW:Participant Status Data Base	Yes
20	FOW:Primary Channel Controller Designate	No
21	FOW:Ranging Assignment	Yes
22	FOW:Relay Ringup	No
23	FOW:Relay Ringup Response	No
24	FOW:Relay Select	No
25	FOW:Relay Select Response	No
26	FOW:Report Status	Yes
27	FOW:Report Terminal Address	Yes
28	FOW:Terminal Address Add or Delete	Yes
29	FOW:Terminal Channel Assignment - 182	Yes
30	FOW:Contention Response	Yes
31	FOW:Zeroize	Yes
32	FOW:Terminal Channel Assignment - 182A	Yes

* Messages not directed to terminals are directed to other CCs.

TABLE II. ROW messages.

MESSAGE TYPE	NAME	TIME SLOT TYPE	ORIGINATED BY TERMINALS*
0	ROW:Alternate Channel Controller Designate	Contention	No
1	ROW:Assign Ranging	Contention	Yes
2	ROW:Channel Controller Login	Contention	No
3	ROW:Channel Controller Status Report	Both	No
4	ROW:Circuit Setup	Contention	Yes
5	ROW:Circuit Teardown	Contention	Yes
6	ROW:Login	Contention	Yes
7	ROW:Logout	Contention	Yes
8	ROW:Message Acknowledgment	Assigned	Yes
9	ROW:Message Setup	Contention	Yes
10	ROW:Message Teardown	Contention	Yes
11	ROW:Multiple-Hop Begin Assignments	Contention	No
12	ROW:Multiple-Hop Circuit Preemption	Contention	No
13	ROW:Multiple-Hop Circuit Resumption	Contention	No
14	ROW:Multiple-Hop Service Teardown	Contention	No
15	ROW:Multiple-Hop Service Teardown Response	Assigned	No
16	ROW:Network Status	Contention	No
17	ROW:Network Status Response	Assigned	No
18	ROW:Blocks Acknowledgment	Assigned	Yes
19	ROW:Primary Channel Controller Designate Response	Assigned	No
20	ROW:Relay Ringup	Contention	No
21	ROW:Relay Ringup Response	Assigned	No
22	ROW:Relay Select	Contention	No
23	ROW:Relay Select Response	Assigned	No
24	ROW:Status Report	Both	Yes
25	ROW:Terminal Address Add or Delete Response	Assigned	Yes
26	ROW:Terminal Address Report	Assigned	Yes
27	ROW:Terminal Channel Assignment Response	Assigned	Yes
28	ROW:Terminal Channel Return	Contention	Yes

NOTE: * Messages marked Yes are originated by terminals or ACCs. Messages marked No are transmitted only by ACCs.

4.2.2 Error control

4.2.2.1 Error detection. Cyclic redundancy checks (CRC) are used for error detection. Two CRC code lengths are used in the transmission of orderwire and communications data. A long code (16 bits) is used on FOW transmissions, on message-service data blocks, and as a check of guard-list consistency. A short code (8 bits) is used on ROW messages and ranging transmissions.

4.2.2.2 Error correction. Error correction encoding and decoding is used for all orderwire messages and selected communications. Forward error correction (FEC) encoding is performed using a rate 1/2, constraint length 7, convolutional code. Higher-rate punctured codes with rates of 3/4 and 7/8, derived from the rate 1/2 code, are supported by the terminal. The decoder performance gain shall be at least that of the Viterbi decoder. Code rate 1 refers to no FEC coding.

4.2.2.3 Interleaving/deinterleaving. Block interleaving is used for selected fields of COM transmissions. The block interleaving structure consists of two independently constructed blocks of 112 code bits used in sequence. The interleaving process is reversed by a deinterleaving operation at the receiver.

4.2.3 Modulation

4.2.3.1 Modulation format. The modulation for all transmissions is interoperable with shaped offset quadrature phase-shift keying (SOQPSK).

4.2.3.2 Modulation rates. The modulation rates shall be 600, 800, 1200, 2400, and 3000 symbols per second (sps), as specified in Table III.

TABLE III. Modulation rates.

TYPE OF BURST	MODULATION RATE (sps)				
	600	800	1200	2400	3000
FOW	X				
ROW Message				X	
ROW Ranging		X			
COM	X		X	X	X

4.3 Terminal performance requirements. The transmit terminal power received at the satellite shall be at least -169 decibels relative to 1 watt (dBW). The terminal receiver system shall be designed to provide error-free reception of the FOW burst for at least 99 of 100 FOW bursts, with a confidence of 98 percent. Error-free reception implies both successful acquisition of the burst and error-free reception of all data covered by the CRC. To satisfy this requirement, it will be assumed that FOWs have an average length of 1400 bits, where FOW length is the value indicated in the FOW field called *Length of This FOW* (see 5.1.1 i) and the controller power received at the satellite is at least -169 dBW. Terminal specifications should define the parameters that must be met for them to comply with the requirements of this paragraph.

4.3.1 Uplink frequency accuracy. The terminal shall control uplink carrier frequency so the signal's carrier frequency at the satellite output is within 400 Hz of the allocated downlink channel frequency. The carrier frequency for FOW bursts from the PCC, at the satellite output, will be within 100 Hz of the allocated downlink channel frequency. The satellite frequency translation error will not exceed 10 Hz. The terminal receiver system shall accommodate these amounts of uplink frequency offset. Note that the frequency offset addressed by this requirement includes errors introduced by terminal and satellite relative velocities and terminal frequency drift.

4.3.2 Terminal duplex. If a terminal can transmit and receive rf signals concurrently, then in the ROW:Login message and ROW:Status Report message the terminal shall identify itself as full-duplex-capable. If a terminal cannot concurrently receive and transmit rf signals, it shall identify itself as half-duplex-capable. A full-duplex-capable terminal may be assigned adjacent transmit and receive time slots directed to this node address; however, a half-duplex terminal will have at least 32 building blocks between any receive and transmit time slot directed to its node address.

4.4 Communications options. This waveform supports circuit and message communications services. Communications options available for circuit services shall be as specified in Table IV. Communications options available for message services shall be as specified in Table V. The PCC directs the modulation and code rates of all COM segment transmissions. The terminal requests a communications service over the ROW to the PCC. Based on this request, end-to-end link-quality criteria, and other considerations, the PCC specifies the modulation and code rate requirements for a time-slot assignment.

4.5 Security characteristics. Security for orderwire, voice, and data is in 5.5.

TABLE IV. Circuit-service communications options.

DATA OR VOICE	I/O DATA RATE (bps)	FULL- OR HALF-DUPLEX (1)	COMPUTED END-TO-END LINK QUALITY C/N_o (dB-Hz)	MODULATION RATE (sps)	CODE RATE (2)	TIME-SLOT SIZE (3)
Data	75	Either	<36.8	600	1/2	166
Data	75	Either	[36.8, 39.8)	1200	1/2	86
Data	75	Either	[39.8, 40.8)	2400	1/2	46
Data	75	Either	[40.8, 42.5)	3000	1/2	38
Data	75	Either	[42.5, 43.5)	2400	3/4	35
Data	75	Either	[43.5, 45.2)	3000	3/4	30
Data	75	Either	[45.2, 48.2)	3000	7/8	27
Data	75	Either	[48.2, 49.2)	2400	1	30
Data	75	Either	≥49.2	3000	1	25
Data	300	Half	<36.8	600	1/2	550
Data	300	Either	[36.8, 39.8)	1200	1/2	278
Data	300	Either	[39.8, 40.8)	2400	1/2	142
Data	300	Either	[40.8, 42.5)	3000	1/2	115
Data	300	Either	[42.5, 43.5)	2400	3/4	99
Data	300	Either	[43.5, 45.2)	3000	3/4	81
Data	300	Either	[45.2, 48.2)	3000	7/8	71
Data	300	Either	[48.2, 49.2)	2400	1	78
Data	300	Either	≥49.2	3000	1	64
Data	600	Half	<39.8	1200	1/2	534
Data	600	Either	[39.8, 40.8)	2400	1/2	270
Data	600	Either	[40.8, 42.5)	3000	1/2	218
Data	600	Either	[42.5, 43.5)	2400	3/4	184
Data	600	Either	[43.5, 45.2)	3000	3/4	149
Data	600	Either	[45.2, 48.2)	3000	7/8	130
Data	600	Either	[48.2, 49.2)	2400	1	142
Data	600	Either	≥49.2	3000	1	115
Data	1200	Half	<40.8	2400	1/2	526
Data	1200	Either	[40.8, 42.5)	3000	1/2	422
Data	1200	Either	[42.5, 43.5)	2400	3/4	355
Data	1200	Either	[43.5, 45.2)	3000	3/4	286

TABLE IV. Circuit-service communications options. (Concluded)

DATA OR VOICE	I/O DATA RATE (bps)	FULL- OR HALF-DUPLEX (1)	COMPUTED END-TO-END LINK QUALITY C/N_o (dB-Hz)	MODULATION RATE (sps)	CODE RATE (2)	TIME-SLOT SIZE (3)
Data	1200	Either	[45.2, 48.2)	3000	7/8	247
Data	1200	Either	[48.2, 49.2)	2400	1	270
Data	1200	Either	≥49.2	3000	1	217
Data	2400	Half	<42.5	3000	1/2	832
Data	2400	Half	[42.5, 43.2)	2400	3/4	696
Data	2400	Half	[43.2, 44.2)	3000	3/4	559
Data	2400	Half	[44.2, 48.2)	3000	7/8	481
Data	2400	Half	[48.2, 49.2)	2400	1	526
Data	2400	Either	≥49.2	3000	1	422
Voice	2400	Half	<42.9	3000	1/2	832
Voice	2400	Half	[42.9, 43.7)	2400	3/4	696
Voice	2400	Half	[43.7, 44.7)	3000	3/4	559
Voice	2400	Half	[44.7, 46.2)	3000	7/8	481
Voice	2400	Half	[46.2, 47.2)	2400	1	526
Voice	2400	Either	≥47.2	3000	1	422

NOTES:

1. Full- or half-duplex attributes refers to operation at the baseband I/O port. A full-duplex (at baseband) service requires assignment of two time slots. For example, to perform a full-duplex (at baseband), 1200-bps service, for which the modulation rate assigned by the PCC is 3000 sps, uncoded in each direction, two 217-building block assignments in the same frame are made by the PCC.

2. Constraint length 7 convolutional code.

3. Time-slot size is the number of building blocks.

TABLE V. Message-service communications options.

COMPUTED END-TO-END LINK QUALITY C/N_o (dB-Hz)	MODULATION RATE (SPS)	CODE RATE (1)	PACKET SIZES (2)	TIME-SLOT SIZE (3)
<32.11	600	1/2	1	83
[32.11, 34.0)	600	1/2	1, 2, 3	83, 126, 169
[34.0, 36.0)	600	1/2	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	83, 126, 169, 211, 254, 297, 339, 382, 425, 467
[36.0, 38.4)	1200	1/2	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 16, 18, 20	44, 66, 87, 108, 130, 151, 172, 194, 215, 236, 279, 322, 364, 407, 450
[38.4, 39.8)	2400	1/2	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 16, 18, 20	25, 36, 47, 57, 68, 79, 89, 100, 111, 121, 143, 164, 185, 207, 228
[39.8, 41.6)	3000	1/2	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 16, 18, 20	22, 30, 39, 47, 56, 65, 73, 82, 90, 99, 116, 133, 150, 167, 184
[41.6, 42.5)	2400	3/4	2, 4, 6, 8, 10, 12, 14, 16, 18, 20	28, 43, 57, 71, 85, 99, 114, 128, 142, 156
[42.5, 43.2)	3000	3/4	2, 4, 6, 8, 10, 12, 14, 16, 18, 20	24, 36, 47, 58, 70, 81, 93, 104, 115, 127
[43.2, 44.9)	3000	7/8	2, 4, 6, 8, 10, 12, 14, 16, 18, 20	23, 32, 42, 52, 62, 71, 81, 91, 101, 110
[44.9, 45.5)	2400	1	2, 4, 6, 8, 10, 12, 14, 16, 18, 20	24, 35, 46, 56, 67, 78, 88, 99, 110, 120
≥45.5	3000	1	2, 4, 6, 8, 10, 12, 14, 16, 18, 20	21, 30, 38, 47, 55, 64, 72, 81, 89, 98

NOTES:

1. Constraint length 7 convolutional code.

2. Packet sizes are in number of 224-bit data blocks to be transmitted within a single burst. The largest listed packet size is assigned unless either (a) the last data blocks in the message are being scheduled and fit into a smaller packet size, or (b) if, at the time at which the service is scheduled, the number of building blocks remaining in the frame being scheduled is less than the number needed for the largest listed packet size.

3. Time-slot size is the number of building blocks.

5. DETAILED REQUIREMENTS

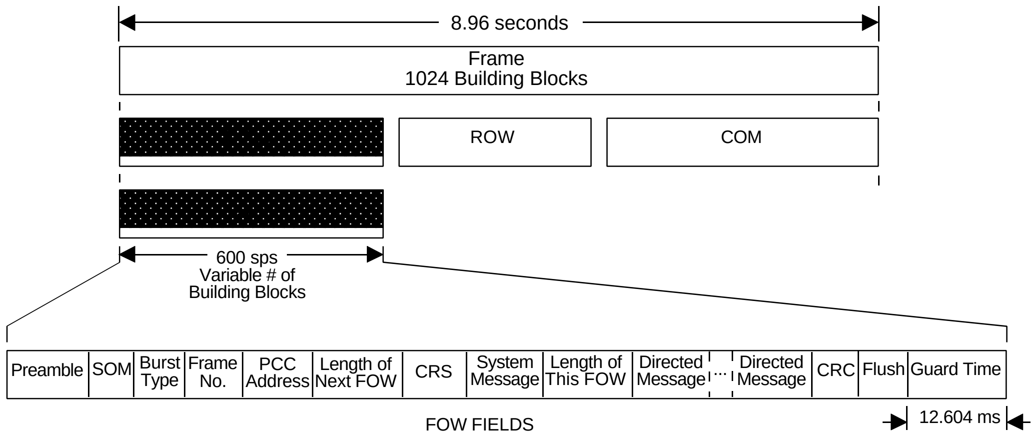
5.1 Waveform requirements. Time in each frame is divided into fixed timing intervals known as *frames*, as shown on Figure 1. Each frame is 8.96 seconds long. The PCC maintains a fixed, 8.96-second frame, within the accuracy permitted by the PCC reference oscillator. The terminals shall synchronize and maintain synchronization with the frame. Frames are divided into 1024 increments known as *building blocks*. A single building block is 8.75 ms long. Building blocks in the frame are grouped in *segments* and *time slots*, which are described below.

a. A frame consists of three segments: The FOW, ROW, and the COM segments, as shown on Figure 1. The FOW segment consists of 1 time slot and is always located at the start of each frame. The ROW segment follows the FOW segment and consists of a variable number of ROW-message time slots, and a variable number of ROW-ranging time slots. The COM segment follows the ROW segment and consists of a variable number of communications message-service-type time slots and communications circuit-service-type time slots.

b. A time slot is a time period allocated for the transmission of an orderwire or communications burst. For a voice service, a time slot in the COM segment can contain more than one burst as described in 5.4.2.2.4.2. Time slots consist of a variable number of 8.75-ms building blocks. Each FOW indicates time-slot start times and time-slot durations for the next frame. There are three types of time slots: (1) the FOW described in 5.1.1; (2) the ROW which has two versions, the ranging version described in 5.1.2.1 and the message version described in 5.1.2.2; and (3) the COM-type time slot which also has two versions, the circuit-service version described in 5.1.3.1 and the message-service version described in 5.1.3.2.

c. Each type of time slot has various fields used for synchronization and the conveyance of information to or from terminals. The fields for each type of time slot are defined in 5.1.1, 5.1.2, and 5.1.3. With the exception of a time slot in the COM segment for a voice service, where multiple bursts per time slot can occur as described in 5.4.2.2.4.2, a time slot is used for a single burst that has one or more fields and includes guard time required to avoid adjacent-time-slot transmission interference. Transmissions shall occur only during authorized time slots.

5.1.1 Forward-orderwire-segment burst fields. The FOW segment starts at absolute building block number 1 in each frame. A FOW burst has 12 information fields and is contained in a single time slot. The fields and the number of bits for each field are illustrated on Figure 2. The terminal shall process and interpret the FOW fields as described below:



FIELD	BITS	ENCRYPTED	CONVOLUTIONAL CODE RATE	INTERLEAVED	CRC	DEFINITION
Preamble	278	N	1	N	N	Redundant time slot preamble
SOM	42	N	1	N	N	Start of message sequence
Burst Type	12	N	1	N	N	Burst type indicator (start of frame)
Frame Number	20	N	1/2	N	N	Frame number
PCC Address	16	Y	1/2	N	Y	Address of transmitting PCC
Length of Next FOW	9	Y	1/2	N	Y	Length of next FOW (in building blocks)
CRS	3	Y	1/2	N	Y	Number of contention-ranging time slots in next frame
System Message	6	Y	1/2	N	Y	Message conveying system status, notifications, and control parameters
Length of This FOW	12	Y	1/2	N	Y	Length of this FOW (in bits)
Directed Messages	Variable	Y	1/2	N	Y	Messages directed to network members conveying resource assignments, status requests, login responses, etc.
CRC	16	Y	1/2	N	N	Cyclic redundancy check for error detection
Flush	6	N	1/2	N	N	Error correction flush bits

FIGURE 2. FOW burst fields definitions.

a. Preamble field. (278 bits). A preamble is transmitted as the initial part of each FOW providing information necessary for signal acquisition and synchronization. The preamble format is a continuous wave (CW) carrier followed by a dot pattern. Using SOQPSK modulation, the preamble during the CW portion is generated with constant data on both the I and Q channels (I = 1, Q = 1). During the dot pattern portion, the preamble consists of alternating data on the I channel (I = 0 1 0 1 . . .) and constant data (Q = 1 1 1 1 . . .) on the Q channel. The length of the preamble and the CW carrier portion of each preamble is defined in Table VI.

TABLE VI. Burst preamble characteristics.

MODULATION RATE (sps)	CW PORTION LENGTH (bits)*	TOTAL PREAMBLE LENGTH (bits)*
600	60	278
800	60	264
1200	60	298
2400	120	358
3000	144	408

NOTE: 2-bits per symbol.

b. Start-of-Message field. (42 bits). The preamble is immediately followed by the 42-bit SOM sequence defined in Table VII. The I channel contains the first SOM field bit transmitted.

TABLE VII. Start-of-Message sequence.

CHANNEL	BIT SEQUENCE
I	000000101110100111001
Q	001101100001000010101

NOTES:
1. Left-most bit transmitted first
2. 21 bits in each sequence

c. Burst Type field. (12 bits). This field immediately follows the SOM sequence. The field distinguishes FOW bursts from other bursts and is also used in COM bursts to indicate to the PCC that a communications service (message or circuit) is to be torn down. Since this field employs FEC code rate 1, the terminal shall be able to identify the burst type when the field is received with up to 3 bit errors in the 12 bits. The Start-of-Frame burst type defined in Table VIII is used on all FOW bursts.

TABLE VIII. Burst Type field.

BURST TYPE	BIT SEQUENCE*
Start-of-Frame	000000000000
Start-of-Slot	110101110101
End-of-Service	011011011011

NOTES:

1. 12 bits in each sequence.
2. Left-most bit transmitted first.

d. Frame Number field. (20 bits). This field identifies the frame number of each frame. The field is set to binary 1 in the frame following a frame that has a System Message value of 15. The frame number will never have a value of zero.

e. PCC Address field. (16 bits). This field identifies the transmitting PCC's address.

f. Length of Next FOW field. (9 bits). This field defines the number of building blocks allocated for the FOW segment in the next frame. With this information in the FOW bursts, and information in the directed messages, the terminal shall determine the position of the time slots in the next frame. (See examples 6.2 through 6.4.)

g. Contention Ranging Slots (CRS) field. (3 bits). This field indicates the number of contention-ranging time slots available in the next frame. (See Table IX.)

TABLE IX. Contention Ranging Slots field.

FIELD VALUE	0	1	2	3	4	5	6	7
NUMBER OF CONTENTION-RANGING TIME SLOTS	1	2	4	6	8	10	12	16

h. System Message field. (6 bits). System messages are transmitted in the System Message field. They provide system status notification and control parameters to all network terminals. The terminal shall interpret all system messages, comply with all applicable system messages, and ignore all system messages that are undefined at the time of terminal construction. Each system message is 6 bits long. FOW system message fields shall be interpreted as specified in Appendix A. One system message is transmitted in each frame. The FOW:System Access Restriction, FOW:ROW Backoff Number, FOW:System Service Restriction On or Off (as applicable), and FOW:Channel Controller

Connected or Isolated (as applicable) messages are transmitted nominally in a 4-frame cycle. Other system messages are transmitted as required, preempting nominal system message transmissions. When these preemptions occur, the preempting message is repeated in four successive frames to provide a high probability of reception.

i. Length of This FOW field. (12 bits). This field defines the length, in bits, of all FOW data in the current frame from (and including) the Frame Number field to (but not including) the CRC field. The Length of This FOW field can be used to locate the CRC field.

j. Directed Messages field. (variable # of bits). The PCC uses directed messages to direct information to subnets or specific terminals. These messages perform such functions as assigning ROW and COM segment time slots, requesting status, updating guard lists, and responding to login or logout requests, among other functions. All FOW requests, notifications, and assignments shall take effect during the frame following the one in which they are received. Each directed message is transmitted to a specific node or subnet. Table I identifies the directed messages and identifies those messages that terminals must implement. Table X identifies required responses to directed messages. Directed messages that assign ROW and COM segment time slots are not transmitted in any predefined order. They can be intermingled, but the order of each directed message that assigns ROW time slots is important in relation to other directed messages that assign ROW time slots. The same is true for the relationship of directed messages that assign COM time slots. FOW directed message shall be interpreted as specified in Appendix B. Future FOW directed message types will have a Length field, 7 bits long, following the Message Type field (see Table B-XXXIII). This allows terminals built to different versions of this standard to parse all FOWs sent by the PCC. For future FOW directed messages, following the 7-bit Length field will be (1) a 1-bit ROW Assignment field that specifies whether or not a ROW-message time slot is assigned by this FOW directed message (if the field has a value 1, then a ROW time slot is assigned), (2) a 1-bit Communications Assignment field that specifies whether or not a COM time slot is assigned by this FOW directed message (if the field has a value 1, then a COM time slot is assigned), and (3) if the Communications Assignment field has a value 1, then a 10-bit Communications Slot Size field follows the Communications Assignment field and specifies the size of the COM time slot in building blocks. Terminals shall not fault on reception of any directed FOW message type that was not completely defined at the terminals' time of construction.

k. CRC field. (16 bits). This field contains bits for error detection as defined in 5.4.3.1.

TABLE X. FOW directed messages and required responses.

TYPE OF FOW MESSAGE	MESSAGE	ROW CAPACITY ALLOCATED	REQUIRED RESPONSE
0	FOW:Acknowledge Message	Yes	ROW:Message Acknowledgment
1	FOW:Acknowledge Blocks	Yes	ROW:Blocks Acknowledgment
2	FOW:Alternate Channel Controller Designate Response	No	
3	FOW:Circuit Assignment	No	
4	FOW:Circuit Setup Response	No	
5	FOW:Circuit Teardown	No	
6	FOW:Login Response	No	
7	FOW:Logout Response	No	
8	FOW:Message Acknowledgment	No	
9	FOW:Message Assignment	No	
10	FOW:Message Setup Response	No	
11	FOW:Message Teardown	No	
12	FOW:Multiple-Hop Begin Assignments Response	No	
13	FOW:Multiple-Hop Circuit Assignment	No	
14	FOW:Multiple-Hop Circuit Preemption Response	No	
15	FOW:Multiple-Hop Service Teardown	Yes	ROW:Multiple-Hop Service Teardown Response
16	FOW:Network Status	Yes	ROW:Network Status Response
17	FOW:Network Status Response	No	
18	FOW:Null Assignment	No	
19	FOW:Participant Status Data Base	No	
20	FOW:Primary Channel Controller Designate	Yes	ROW:Primary Channel Controller Designate Response
21	FOW:Ranging Assignment	Yes	None
22	FOW:Relay Ringup	Yes	ROW:Relay Ringup Response
23	FOW:Relay Ringup Response	No	

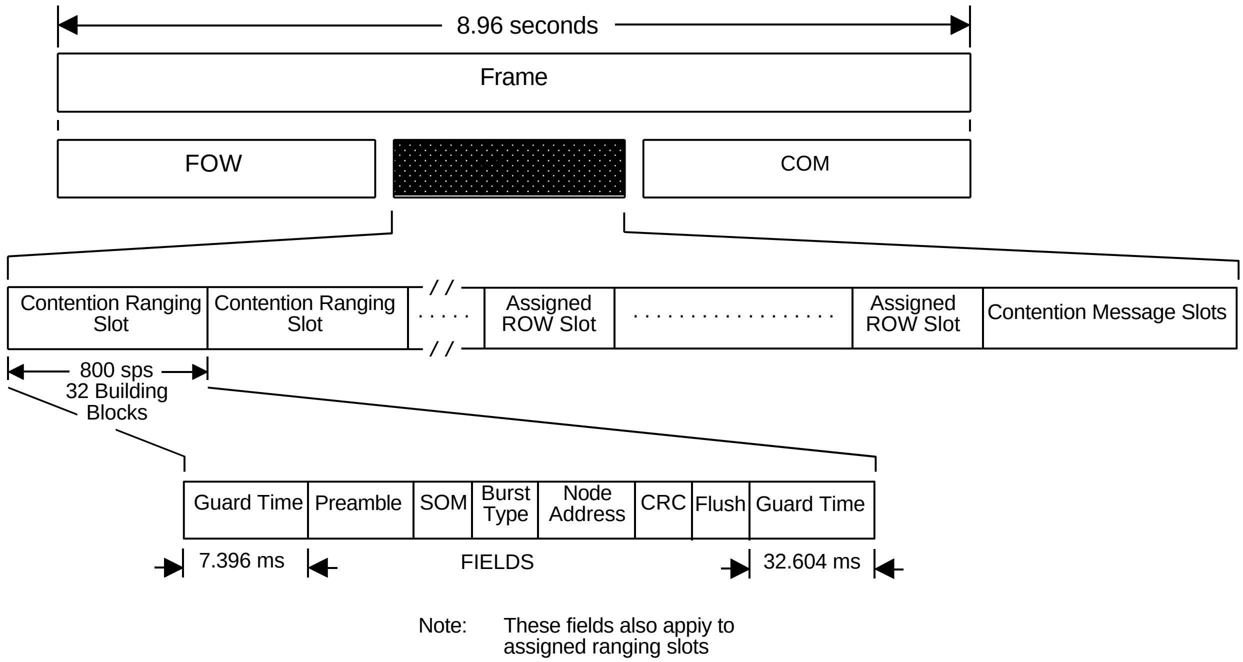
TABLE X. FOW directed messages and required responses. (Concluded)

TYPE OF FOW MESSAGE	MESSAGE	ROW CAPACITY ALLOCATED	REQUIRED RESPONSE
24	FOW:Relay Select	Yes	ROW:Relay Select Response
25	FOW:Relay Select Response	No	
26	FOW:Report Status	Yes	ROW:Status Report or ROW:Channel Controller Status Report
27	FOW:Report Terminal Addresses	Yes	ROW:Terminal Addresses Report
28	FOW:Terminal Address Add or Delete	Yes	ROW:Terminal Address Add or Delete Response
29	FOW:Terminal Channel Assignment - 182	Yes	ROW:Terminal Channel Assignment Response
30	FOW:Contention Response	No	
31	FOW:Zeroize	No	
32	FOW:Terminal Channel Assignment - 182A		

l. **Flush field**. (6 bits). This field contains data bits of value zero for flushing the forward error correction (FEC) encoder.

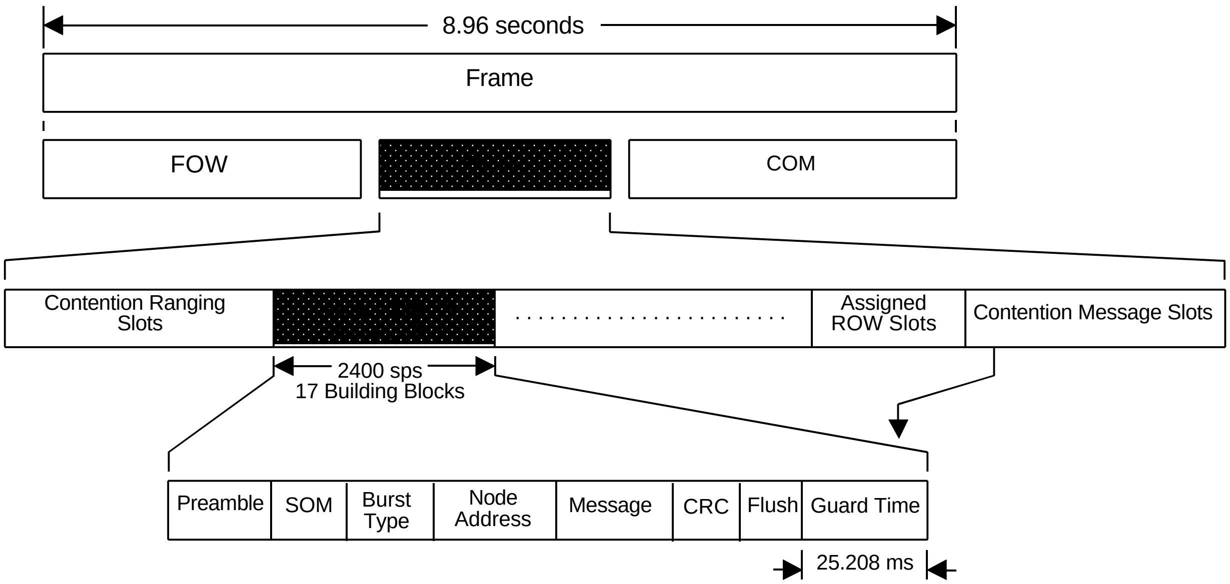
5.1.2 Return orderwire segment. The ROW segment begins immediately following the last building block in the FOW time slot. The ROW segment will be made up of a variable number of time slots, each of which is either a ranging time slot or a message time slot. A ranging time slot is 32 building blocks long with fields as defined on Figure 3. A message time slot is 17 building blocks long with fields as defined on Figure 4. The first time slots are contention-ranging time slots. They are used by terminals to perform initial ranging, as defined in 5.2.2.1.1. The contention-ranging time slots are followed by assigned message and ranging time slots which may be intermingled. Assigned message and ranging time slots are followed by contention-message time slots. Contention-message time slots are used by terminals to send ROW messages for which the PCC does not assign a time slot.

5.1.2.1 Return orderwire ranging burst fields. ROW ranging bursts shall be comprised of six fields, as shown on Figure 3. A ranging time slot is 32 building blocks long. The ranging time-slot size allows a guard time of 7.396 ms prior to the



FIELD	BITS	ENCRYPTED	CONVOLUTIONAL CODE RATE	INTERLEAVED	CRC	DEFINITION
Preamble	264	N	1	N	N	Redundant time slot preamble
SOM	42	N	1	N	N	Start-of-Message Sequence
Burst Type	12	N	1	N	N	Burst type indicator (Start of Slot)
Node Address	16	Y	1/2	N	Y	Terminal or CC Node Address
CRC	8	Y	1/2	N	N	Cyclic redundancy check for error detection
Flush	6	N	1/2	N	N	Error correction flush bits

FIGURE 3. ROW-ranging fields definitions.



Note: These fields also appiy to ROW contention message time slots

FIELD	BITS	ENCRYPTED	CONVOLUTIONAL CODE RATE	INTERLEAVED	CRC	DEFINITION
Preamble	358	N	1	N	N	Redundant time-slot preamble
SOM	42	N	1	N	N	Start-of-Message Sequence
Burst Type	12	N	1	N	N	Burst Type Indicator (Start of Slot)
Node Address	16	Y	1/2	N	Y	Terminal or CC node address
Message	60	Y	1/2	N	Y	ROW message
CRC	8	Y	1/2	N	N	Cyclic redundancy check for error detection
Flush	6	N	1/2	N	N	Error correction flush bits

FIGURE 4. ROW-message fields definitions.

nominal transmit time, and 32.604 ms of guard time after the nominal transmit time (see Figure 3). Considering that the last 12.604 ms of the assigned time slot is allocated to the following time slot, the total guard time before and after the nominal transmit time is 20.0 ms. The six ranging burst fields are described below:

a. Preamble field. (264 bits). This field shall be as defined in 5.1.1 a for 800-sps modulation.

b. Start-of-Message field. (42 bits). This field shall be as defined in 5.1.1 b.

c. Burst Type field. (12 bits). This field shall be the Start-of-Slot bit sequence as defined in 5.1.1 c.

d. Node Address field. (16 bits). This field shall identify the transmitting terminal's login address.

e. CRC field. (8 bits). This field shall contain bits for error detection, as defined in 5.4.3.1.

f. Flush field. (6 bits). This field shall contain bits of value zero for flushing the FEC encoder.

5.1.2.2 Return orderwire message burst fields. The ROW message burst shall be constructed in accordance with Figure 4. ROW messages shall be as specified in Appendix C. Table XI lists the expected PCC response to each ROW message. The seven fields are described below:

a. Preamble field. (358 bits). This field shall be as defined in 5.1.1 a for 2400-sps modulation.

b. Start-of-Message field. (42 bits). This field shall be as defined in 5.1.1 b.

c. Burst Type field. (12 bits). This field shall be the Start-of-Slot bit sequence, as defined in 5.1.1 c.

d. Node Address field. (16 bits). This field shall identify the transmitting terminal's login address. If the ROW message pertains to a communications service, the node address, together with the virtual port number in the ROW message, uniquely identifies the service to the PCC. If the PCC sends a FOW directed message pertaining to a communications service, the same information uniquely identifies the service to all terminals.

e. Message field. (60 bits). This field shall contain the ROW message being transmitted to the PCC. ROW messages are defined in Appendix C.

TABLE XI. ROW messages and FOW responses.

ROW MESSAGE TYPE	ROW MESSAGE	ASSIGNED/ CONTENTION ROW	FOW ACKNOWLEDGMENT MESSAGE *
0	ROW:Alternate Channel Controller Designate	Contention	FOW:Alternate Channel Controller Designate Response
1	ROW:Assign Ranging	Contention	FOW:Ranging Assignment
2	ROW:Channel Controller Login	Contention	FOW:Login Response
3	ROW:Channel Controller Status Report	Assigned/ Contention	FOW:Contention Response
4	ROW:Circuit Setup	Contention	FOW:Circuit Setup Response, FOW:Circuit Assignment, FOW:Multiple-Hop Circuit Assignment, or FOW:Terminal Channel Assignment
5	ROW:Circuit Teardown	Contention	FOW:Circuit Teardown
6	ROW:Login	Contention	FOW:Login Response
7	ROW:Logout	Contention	FOW:Logout Response
8	ROW:Message Acknowledgment	Assigned	
9	ROW:Message Setup	Contention	FOW:Message Setup Response or FOW:Message Assignment
10	ROW:Message Teardown	Contention	FOW:Message Teardown
11	ROW:Multiple-Hop Begin Assignments	Contention	FOW:Multiple-Hop Begin Assignments Response
12	ROW:Multiple-Hop Circuit Preemption	Contention	FOW:Multiple-Hop Circuit Preemption Response
13	ROW:Multiple-Hop Circuit Resumption	Contention	FOW:Multiple-Hop Circuit Assignment
14	ROW:Multiple-Hop Service Teardown	Contention	FOW:Multiple-Hop Service Teardown
15	ROW:Multiple-Hop Service Teardown Response	Assigned	
16	ROW:Network Status	Contention	FOW:Network Status Response
17	ROW:Network Status Response	Assigned	
18	ROW:Blocks Acknowledgment	Assigned	

TABLE XI. ROW messages and FOW responses (concluded).

ROW MESSAGE TYPE	ROW MESSAGE	ASSIGNED/ CONTENTION ROW	FOW ACKNOWLEDGMENT MESSAGE *
19	ROW:Primary Channel Controller Designate Response	Assigned	
20	ROW:Relay Ringup	Contention	FOW:Relay Ringup Response
21	ROW:Relay Ringup Response	Assigned	
22	ROW:Relay Select	Contention	FOW:Relay Select Response
23	ROW:Relay Select Response	Assigned	
24	ROW:Status Report	Assigned/ Contention	FOW:Contention Response
25	ROW:Terminal Address Add or Delete Response	Assigned	
26	ROW:Terminal Addresses Report	Assigned	
27	ROW:Terminal Channel Assignment Response	Assigned	
28	ROW:Terminal Channel Return	Contention	FOW:Contention Response

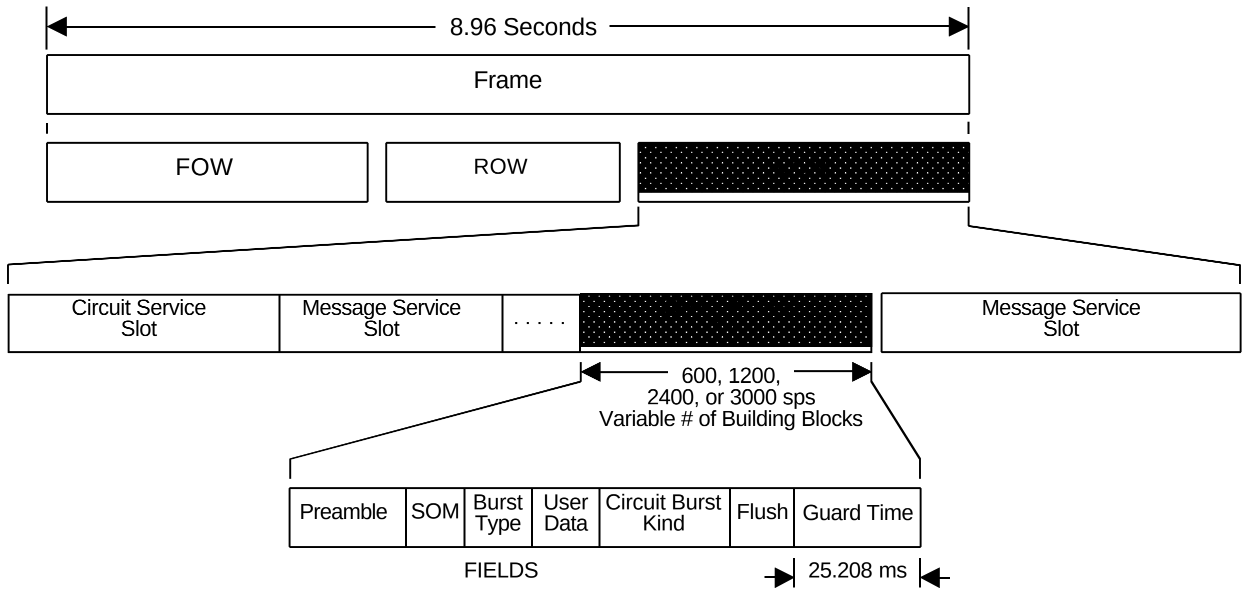
NOTE: * Sent only in response to a contention ROW.

f. CRC field. (8 bits). This field shall contain bits for error detection, as defined in 5.4.3.1.

g. Flush field. (6 bits). This field shall contain bits of value zero for flushing the FEC encoder.

5.1.3 Communications segment. Network communications shall be conducted in an assigned time slot within the frame's communications segment. The communications segment follows the ROW segment and consists of time slots that vary in number and length. There are two types of communications time slots: circuit service and message service.

5.1.3.1 Circuit-service burst fields. The circuit-service burst shall consist of six fields, as illustrated on Figure 5. If there are multiple bursts in a frame each burst will be allowed the guard time indicated on Figure 5. The fields are described below:



FIELD	BITS	ENCRYPTED	CONVOLUTIONAL CODE RATE	INTERLEAVED **	DEFINITION	
Preamble	Variable	N	1	N	Burst Rate	Preamble Length (Bits)
					600	278
					1200	298
					2400	358
					3000	408
SOM	42	N	1	N	Start-of-Message sequence	
Burst Type	12	N	1	N	Burst type indicator	
User Data	Variable	N *	***	Y	See 5.4.2.2.4 and 5.4.2.2.5	
Circuit Burst Kind	8	N	***	N	See 5.4.2.2.4 and 5.4.2.2.5	
Flush **	6	N	***	N	Error correction flush bits	

NOTES:

* Data may be encrypted by the user baseband device.
** Applicable only if the communications is assigned to be error correction coded other than code rate 1.
*** Applicable rates are 1, 7/8, 3/4, and 1/2 (see Table IV and 5.4.3.2).

FIGURE 5. Circuit-service fields definitions.

a. Preamble field. This field shall consist of a variable number of bits based on the modulation rate, as defined in 5.1.1 a.

b. Start-of-Message field. (42 bits). This field shall be as defined in 5.1.1 b.

c. Burst Type field. (12 bits). The End-of-Service burst type defined in Table VIII shall be used on any COM burst for which the terminal is attempting to tear down the service, as described in 5.4.2.5.6. The Start-of-Slot burst type defined in Table VIII shall be used on all other bursts.

d. User Data field (variable). This field shall contain user baseband data. Field size depends on the I/O rate of the baseband equipment. (See 5.4.2.2.4.)

e. Circuit Burst Kind field. (8 bits). This field identifies whether the burst is (1) the first burst of a transmission that consists of at least one additional burst; (2) a nominal burst, not the first or last burst of a transmission; (3) the second from last burst of a transmission (not used in every transmission); or (4) the last burst of a transmission (see 5.4.2.2.4 and 5.4.2.2.5).

f. Flush field. (6 bits). This field shall contain bits of value zero for flushing the FEC encoder.

5.1.3.2 Communications message-service burst fields. The communications message-service burst shall be constructed as shown on Figure 6. Figure 6 illustrates the burst format. The fields are described below:

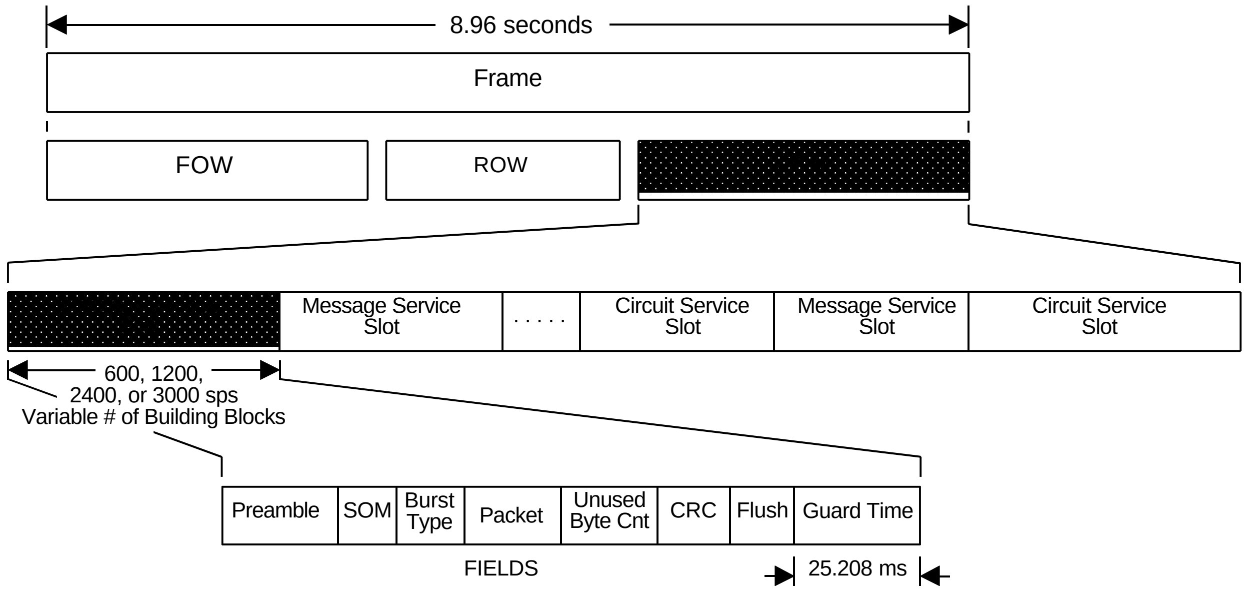
a. Preamble field. This field shall consist of a variable number of bits based on modulation rate, as defined in 5.1.1 a.

b. Start-of-Message field. (42 bits). This field shall be as defined in 5.1.1 b.

c. Burst Type field. (12 bits). The End-of-Service burst type defined in Table VIII shall be used on any COM burst for which the terminal is attempting to tear down the service, as described in 5.4.2.5.6. The Start-of-Slot burst type defined in Table VIII shall be used on all other bursts.

d. Packet field. (Variable # of bits). This field shall contain an integer number of data blocks as defined in Table V. Each data block is 224 bits. Message services are described in 5.4.2.3.2.

e. Unused Byte Counter field. (8 bits). This field shall identify the number of unused (fill) bytes in the last message packet (see 5.4.2.3.2.5).



FIELD	BITS	ENCRYPTED	CONVOLUTIONAL CODE RATE	INTERLEAVED **	CRC	DEFINITION
Preamble	Variable	N	1	N	N	Burst Rate / Preamble Length (Bits) 600 / 278 1200 / 298 2400 / 358 3000 / 408
SOM	42	N	1	N	N	Start-of-Message sequence
Burst Type	12	N	1	N	N	Burst type indicator
Packet	Variable	N*	***	Y	Y	See 5.4.2.3.2
Unused Byte Counter	8	N	***	N	Y	See 5.4.2.3.2.5
CRC	16	N	***	N	N	Cyclic redundancy check for error detection
Flush **	6	N	***	N	N	Error correction flush bits

NOTES:

* Data may be encrypted by the user baseband device.
** Applicable only if the communications is assigned to be error correction coded other than code rate 1.
*** Applicable rates are 1, 7/8, 3/4, and 1/2 (see Table V and 5.4.3.2).

FIGURE 6. Message-service fields definitions.

f. CRC field. (16 bits). This field shall contain bits for error detection, as defined in 5.4.3.1.

g. Flush field. (6 bits). This field shall contain bits of value zero for flushing the FEC encoder.

5.1.4 Data field transmission. Data fields shall be transmitted in the sequence defined by Figures 2, 3, 4, 5, and 6. For each field, the MSB (the left-most bit) shall be transmitted first. For example, if the address of a terminal is 0000000011110101 (245), the first bits transmitted are the leading zeros.

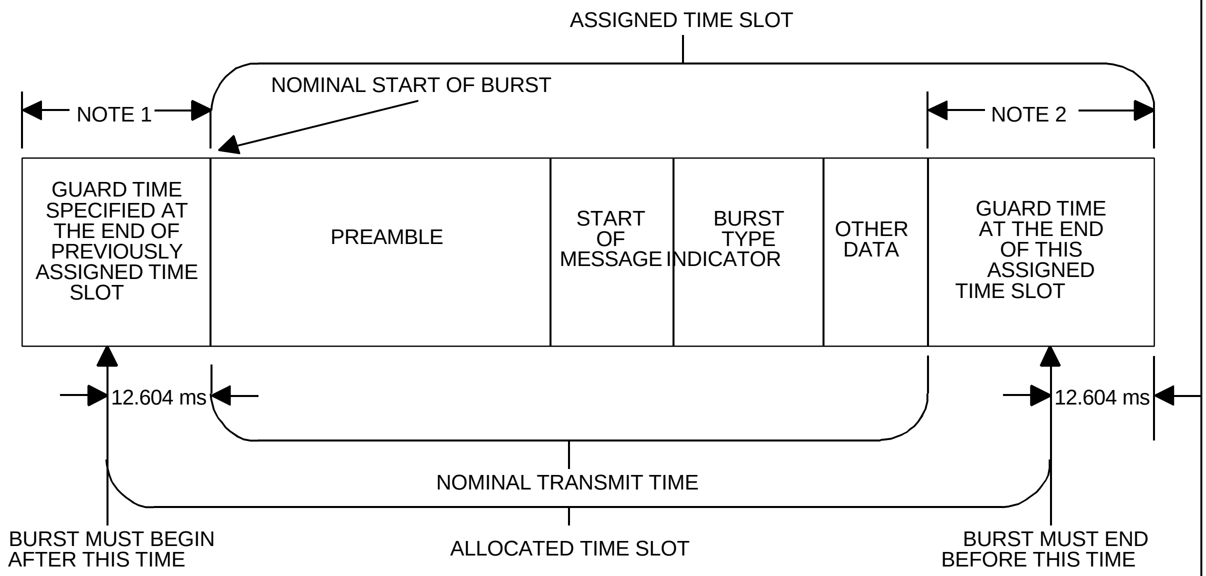
5.1.4.1 Serial I/O bit order within data fields. The first bit entering the terminal from the I/O device shall be the MSB (the left-most bit) appearing in the Packet field (for message service) or User Data field (for circuit service) and shall be the first bit transmitted from the Packet or User Data field.

5.1.4.2 Parallel I/O bit order within data fields. The terminal specification should define the bit order between the terminal and the I/O device with respect to the bit order appearing within the Packet or User Data field.

5.1.5 System guard time. Each terminal shall ensure that its transmissions always fall within its allocated time slots, as depicted on Figure 7. The nominal start of a nonranging transmission always coincides with the beginning of an assigned time slot. The allocated time slot, in each case, includes the nominal transmit time within the assigned time slot, plus 12.604 ms of guard time preceding the assigned time slot, and all but the last 12.604 ms of the guard time specified within the assigned time slot. This results in a guard time of at least 12.604 ms provided before and after the nominal burst time, except for FOW and ranging time slots.

a. Segment guard time. The FOW defines system timing; therefore, no guard time is needed for the FOW. For the FOW time slot, all of the 12.604-ms guard time specified at the end of the assigned time slot is allocated to the first contention-ranging time slot. For ranging time slots, the 12.604-ms guard time at the end of the previous time slot and initial guard time ahead of the burst in the assigned time slot combine to provide 20 ms of guard time before the nominal burst time. Subtracting 12.604 ms from the guard time specified at the end of the assigned time slot results in 20 ms of guard time allocated after the nominal burst time.

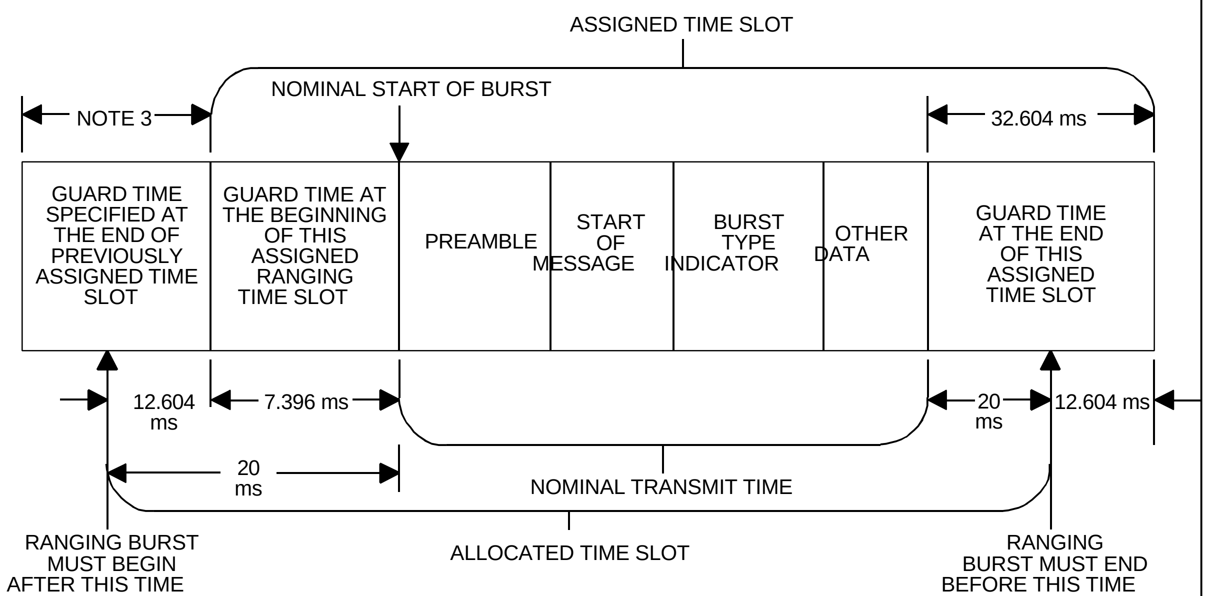
b. Uplink timing maintenance. Terminals can maintain uplink timing by performing periodic range measurements (that is,



NOTE 1: At least 25.208 ms if previous time slot is ROW message or communications time slot.
At least 32.604 ms if previous time slot is ROW ranging.

NOTE 2: At least 25.208 ms if assigned time slot is ROW message or communications time slot.
At least 12.604 ms if assigned time slot is FOW slot, i.e., there is no guard time at the end of the allocated FOW time slot.

FIGURE 7a. Allocated guard times for bursts except ranging



NOTE 3: At least 25.208 ms if previous time slot is ROW message time slot.
At least 32.604 ms if previous time slot is ROW ranging time slot.
At least 12.604 ms if previous time slot is FOW slot, i.e., all of the guard time at the end of the previous time slot (if a FOW slot) is allocated to the ranging time slot.

FIGURE 7b. Allocated guard times for ranging bursts

FIGURE 7. Allocated guard times for bursts.

active ranging) in ROW-ranging time slots allocated for that purpose. However, active ranging is not required if timing accuracy can be otherwise determined and maintained. Terminal design shall prohibit the use of contention-ranging time slots except when (1) performing initial ranging (prior to login), or (2) its uplink timing error becomes excessive. If active ranging is used, the terminal design shall maintain uplink timing within 12.604 ms for a period of at least 4.6 hours following a successful range.

5.2 Synchronization. Terminal timing shall be aligned with PCC timing. Prior to logging into the network, each terminal shall perform downlink and uplink acquisition to align its frame timing with that of the PCC. Thereafter, each terminal shall track the downlink and perform ranging (active or passive) to maintain uplink timing. The terminal can also maintain timing by making adjustments based on measured changes in frame timing. For this purpose the terminal can assume that the PCC time accuracy is 5×10^{-8} or better, and the PCC will be on a stationary platform.

5.2.1 Downlink synchronization. Prior to initiation of any network transmission, the terminal shall perform downlink acquisition. When the terminal successfully completes initial frame acquisition and is able to interpret the FOW, downlink acquisition is achieved. Terminal downlink synchronization acquisition and maintenance requirements are as follows:

a. Initial frame acquisition shall involve (1) acquisition of downlink symbol timing by acquiring the FOW preamble, (2) acquisition of downlink time-slot timing by detecting the FOW SOM sequence, and (3) acquisition of frame timing by detecting the unique Start-of-Frame burst type indicator.

b. If the terminal achieves initial frame acquisition, the terminal shall attempt to interpret the FOW by proceeding with error correction decoding (see 5.4.3.2), decryption (see 5.5.1), and CRC validation (see 5.4.3.1). When the FOW is correctly decoded, decrypted, and CRC-checked, downlink acquisition is considered successful.

c. The terminal shall terminate uplink transmission upon loss of the downlink synchronization (loss of the FOW). If no FOW burst is received for 200 consecutive frames, the terminal shall assume that login and service request information at the PCC is lost. If downlink acquisition is recovered within 200 frames, the terminal shall not log in or retransmit service requests previously acknowledged by the PCC.

5.2.2 Uplink synchronization. Prior to network login, a terminal shall perform uplink acquisition. Terminals that use active ranging shall range in the contention-ranging time slots. If a ranging attempt is successful, or if the terminal determines uplink timing in some other manner, uplink acquisition is successful. If the terminal's initial active ranging attempt is not successful, it will proceed as specified in 5.2.2.1.2.

5.2.2.1 Terminal active ranging. Terminals that perform active ranging shall set the Ranging Flag field of the ROW:Login message to *Active*. To perform active ranging, a terminal shall transmit a short burst, as specified in 5.1.2.1 and on Figure 3, and shall measure the round-trip propagation time to the satellite. The propagation time value is then used to ensure that terminal timing is aligned with PCC timing. Terminals may compute changes in satellite ranges based on when FOWs are received. Terminals that use this method should monitor for a change in the FOW's PCC address as this may be accompanied by a jump in FOW timing.

5.2.2.1.1 Terminal contention ranging. Prior to login, the terminal may perform initial ranging in contention-ranging time slots. If initial ranging is unsuccessful, subsequent ranging attempts shall occur in contention-ranging time slots of frames determined by the algorithm defined in 5.2.2.1.2. A terminal that performs active ranging is permitted to perform an initial attempt (in a contention-ranging time slot) in any frame prior to login, and in any frame after its uplink timing error becomes excessive.

5.2.2.1.2 Contention-ranging backoff algorithm. Following an unsuccessful attempt to range in a contention-ranging time slot, the terminal shall select a frame and time slot for further contention-ranging attempts. The contention-ranging time slot in which to retransmit shall be selected using an algorithm that uses two levels of randomization. The first level determines the frame in which retransmission of the ranging message is to occur. The second level determines the contention-ranging time slot for retransmission of the ranging message. The contention-ranging time slot selection process shall be as defined in 5.2.2.1.2 a and b:

a. Determining frame. To determine the frame in which to retransmit the contention-ranging message, the terminal uses the acquisition backoff number. For initial retransmission, the value of the acquisition backoff number is 2. For the second through sixth retransmissions, the value of the acquisition backoff number is 5, 10, 50, 100, and 250, respectively. All further retransmissions use an acquisition backoff number of 250. The terminal derives a uniformly distributed random number *(U1)* between 1 and the acquisition backoff number, inclusive. Starting at the next frame, the terminal determines the accumulated number of contention-ranging time slots (see 6.4).

The frame in which the accumulated number equals or exceeds *U1* is the frame for retransmission of the contention-ranging message.

b. Time slot determination. To determine the time slot in which to retransmit the contention-ranging message, the terminal derives a uniformly distributed random number (*U2*) between 1 and the number of contention-ranging time slots inclusive, in the frame determined in a, above. The terminal uses the contention-ranging time slot *U2* for retransmission of the contention-ranging message.

5.2.2.1.3 Terminal assigned ranging. The PCC allocates assigned-ranging time slots to all logged-in participants in the satellite coverage area if they logged-in as active ranging terminals. The interval between assigned-ranging time slots does not exceed 4.5 hours for each participant. If active ranging is used, the terminal shall range using the time slot defined by the FOW:Ranging Assignment message. Terminal ranging in assigned versus contention ranging time slots shall be as follows:

a. If a terminal performs active ranging and does not receive a FOW:Ranging Assignment message within 4.5 hours since the time it most recently ranged successfully, or if the ranging in an assigned time slot is unsuccessful, the terminal shall request an assignment to range. The request shall be sent in the contention portion of the ROW, using a ROW:Assign Ranging message.

b. If an active ranging terminal does not successfully range prior to its uplink timing error exceeding ±12.604 ms, the terminal shall inhibit transmissions (other than ranging) until ranging is successfully performed. If a terminal performs active ranging and its uplink timing error becomes excessive (that is, no longer within ±12.604 ms), the terminal shall range in the contention-ranging time slot, as defined in 5.2.2.1.1.

5.2.2.2 Terminal passive ranging. Terminals that perform passive ranging shall set the Ranging Flag field of the ROW:Login message to *Passive*. The PCC will not allocate assigned-ranging time slots to the logged-in terminals that use passive ranging. Any terminal that has identified itself as performing passive ranging may request a ranging time slot using a ROW:Assign Ranging message. The terminal shall then transmit a ranging burst, as specified in 5.1.2.1, in the assigned time slot.

5.3 Link quality measurement. The terminal shall report link quality to the PCC at login using a ROW:Login message or, when requested, using a ROW:Status Report message. The terminal shall report the carrier-power to noise-spectral-density ratio (C/N_o) of the received FOW:

a. to within ±2 dB-Hz if reported within 5 minutes of downlink acquisition and the actual C/N_o is between 32.1 and 49.2 dB-Hz,

b. to within ±1 dB-Hz if reported more than 5 minutes after downlink acquisition and the actual C/N_o is between 32.1 and 49.2 dB-Hz,

c. as a value greater than 47 dB-Hz if the actual C/N_o is greater than 49.2 dB-Hz,

d. as a value less than 34.5 dB-Hz if the actual C/N_o is less than 32.1 dB-Hz.

5.4 Communications characteristics

5.4.1 Communications services

5.4.1.1 TDMA communications services. The DAMA protocols support a mixture of circuit services and message services. Circuit services may be either preassigned or demand-assigned whereas message service is only demand-assigned. Preassigned circuit services are set up by the PCC and assigned to the terminal in the FOW:Circuit Assignment message. The Virtual Port field of the FOW identifies the service as preassigned. Preassigned circuit services are not subject to preemption, as are demand-assigned services. Table XII lists the types of services available for local (operating within a single satellite footprint) and global (involving multiple-hop routing) coverage. Multiple-hop routing is accomplished by a relay capability, within the control station, that can transfer information between channels in a global network. Point-to-point operation involves two terminals. Subnet operation can involve communications among any number of terminals, but is set up only when two or more participating terminals are logged in.

TABLE XII. Communications services.

COMMUNICATIONS SERVICE	OPERATION	TYPE OF SERVICE	END-TO-END ACKNOWLEDGMENT	COVERAGE AREA
Circuit (Data/Voice)	Point-to-point	Full-duplex	No	Local/global
Circuit (Data/Voice)	Point-to-Point	Half-duplex	No	Local/global
Circuit (Data/Voice)	Subnet	Half-duplex	No	Local
Message (Data)	Point-to-Point	Simplex	Yes	Local/global
Message (Data)	Subnet	Simplex	No	Local

5.4.1.1.1 Circuit service. Circuit service provides a communications path between terminals over which one-way or two-way communications can take place. Half-duplex service provides two-way communications, but with the communications in only one direction (from one source terminal) at a time. For a half-duplex circuit service, a single time slot is assigned in each frame, and the addressed terminals must coordinate the use of the time slot to prevent interference. A full-duplex circuit service is assigned two time slots in each frame, permitting communications in two directions during the frame. The terminal shall provide circuit service at data I/O rates of 75, 300, 600, 1200, and 2400 bps and at the digital voice rate of 2400 bps, as indicated in Table XIII.

TABLE XIII. Circuit communications I/O data rates.

COMMUNICATIONS CIRCUIT	FULL- OR HALF-DUPLEX SERVICE	I/O DATA RATE (bps)				
		75	300	600	1200	2400
Data Circuit	Half-Duplex	X	X	X	X	X
Data Circuit	Full-Duplex	X	X	X	X	X
Voice Circuit	Half-Duplex					X
Voice Circuit	Full-Duplex					X

5.4.1.1.2 Message service. A message service provides communications resources for the transmission of data, using a block protocol. All message services are simplex services. A simplex service is one in which a single terminal is the source for all transmissions. Messages shall be less than or equal to 114,688 bits, which is equivalent to 512 blocks of 224 bits each. Cryptographic equipment preambles and pad bits shall be included in the 114,688-bit maximum. For asynchronous baseband equipment, start, stop, and parity bits, if not encrypted, shall be stripped by the transmitting terminal and reinserted by the receiving terminal. These stripped and reinserted bits are therefore not transmitted over the air or included in the 114,688-bit maximum.

5.4.1.2 Multiple-channel network operations. Multiple-channel network operations shall take place on the channels listed in Appendix D. Multiple-channel operations will include a number of TDMA channels (5- or 25-kHz) and a number of single-access channels (5- or 25-kHz). Multiple-channel operations can occur by assignment to another DAMA channel (see 5.4.1.2.1) or assignment to a DASA channel (see 5.4.1.2.2).

5.4.1.2.1 TDMA channel reassignment. A terminal operating on a TDMA channel shall change to a new TDMA channel only when directed by the PCC. The direction to change channels shall be by the FOW:Terminal Channel Assignment message. The terminal shall change to the channel identified in the FOW. If the Channel Type field is set to binary 0, the channel operates in the DAMA mode via the same satellite. The terminal shall determine, based on the Channel field and Appendix D, whether the assigned channel is 5- or 25-kHz. Only terminals capable of automatic frequency change and 25-kHz operations will be directed to switch to a 25-kHz TDMA waveform. If the assigned channel is 5-kHz, the DAMA waveform shall be as specified in this standard. If the assigned channel is 25-kHz, the DAMA waveform shall be as specified in MIL-STD-188-183. The terminal shall attempt to achieve downlink and uplink synchronization in the new channel. If the terminal cannot achieve downlink and uplink synchronization on the assigned channel within 90 seconds, the terminal shall return to the previous channel of operation. If the terminal is switching from a 5-kHz DAMA channel to another 5-kHz DAMA channel, the terminal shall retain all pending service requests it held in queue and shall not send a ROW:Login message on the new channel. If the terminal is switching from a 5-kHz DAMA channel to a 25-kHz DAMA channel, the terminal shall clear (delete) all pending service requests held in its queue. After a terminal has achieved downlink and uplink acquisition on a newly assigned TDMA channel (5- or 25-kHz), it shall not return to the previous channel or change to any other channel unless directed by the PCC.

5.4.1.2.2 DASA channel assignment. A DASA channel provides a 5- or 25-kHz UHF SATCOM single-access channel over which two terminals (point-to-point) or multiple terminals (subnet) can communicate. Only terminals that are automatic frequency change and single-access operations capable will be switched to a DASA channel. Terminals may be switched to DASA channels being controlled by a single PCC. While operating on a TDMA channel, the terminal shall change to a DASA channel only when directed by the PCC. Operation on the assigned DASA channel operation shall be as specified in 5.4.2.4.2.

5.4.2 Communications protocols

5.4.2.1 TDMA access control

5.4.2.1.1 Preassignment of circuit services. Any point-to-point circuit service can be preassigned. Additionally, among terminals on a single satellite channel, subnet circuits can be preassigned. Setup, control, and teardown of the preassigned services are performed at the control station. When the preassigned service is set up, the PCC designates the source and destination terminals. The source terminal must be within the satellite coverage area controlled by the PCC. The source terminal need not be logged into the network at the time a preassigned circuit is set up. The destination terminal(s) also need not be logged into the local network at the time a preassigned circuit is set up if the service is local (single footprint). However, if a destination terminal is located in a different satellite coverage area (that is, the service is multiple-hop), the destination terminal must be logged into its local PCC at the time the service is set up. Preassigned circuit service management shall be as follows:

a. If the control station operator requests the setup of a preassigned circuit service and at least two participating terminals are logged in, the service is considered active and the PCC makes assignments using FOW:Circuit Assignment messages. When other participating terminals log in, they are notified of an active preassigned service via the FOW:Circuit Assignment message.

b. If the control station operator requests the set up of a preassigned circuit service and fewer than two participating terminals are logged in, the PCC retains it in a dormant state in which assignments are not made. The service remains dormant until at least two participants log in, at which time the state of the service transitions to active and the PCC issues FOW:Circuit Assignment messages to the logged-in participants.

c. As terminals log out or when a guard list changes such that fewer than two service participants are logged in, the preassigned circuit enters the dormant state and the PCC sends the FOW:Circuit Teardown message to participating terminals. When the control station operator explicitly tears down the preassigned circuit, the PCC uses a FOW:Circuit Teardown message to notify terminals. Multiple-hop preassigned circuits may be automatically torn down if there is an interruption in the relay communications connectivity established when the setup of the preassigned service was requested.

d. A terminal shall respond to FOW messages while participating on a preassigned circuit. ROW service requests from a terminal involved in a preassigned point-to-point circuit, and point-to-point services addressed to a terminal involved in a preassigned point-to-point circuit, are not set up until the preassigned service is torn down. If service requests are made by a terminal prior to the setup of a preassigned point-to-point service involving that terminal, the requested service remains blocked until either it becomes active or is torn down, as specified in 5.4.2.1.6.4. When a terminal is preassigned in a point-to-point service, its queued service requests will become blocked and any active services having that terminal's address as a source or destination address will also become blocked. Terminals receive resource assignments for preassigned circuit services in the FOW:Circuit Assignment or FOW:Multiple-Hop Circuit Assignment message.

5.4.2.1.2 Precedence and preemption. The waveform supports preemption of lower-precedence, demand-assigned communications by higher-precedence communications. Terminals shall originate each service request at one of five levels of precedence. In decreasing order of precedence, these levels are Flash Override, Flash, Immediate, Priority, and Routine. After a service is assigned communications resources, the lack of a service assignment in a FOW burst indicates the service is preempted.

5.4.2.1.3 Access restrictions. The PCC can restrict access to network resources through terminal access restriction, system access restriction, and system service restriction.

5.4.2.1.3.1 Terminal access restriction. Terminal access restriction, a terminal attribute set at the control station, defines the maximum precedence for communications traffic originated by the terminal. Terminal access restriction does not apply to services assigned to a destination terminal. Terminal access restriction is provided to a terminal in the FOW:Login Response message. No service request whose precedence exceeds the terminal access restriction shall be transmitted by the terminal, unless the destination address is zero (numeric value). See 5.4.2.5.1.2.

5.4.2.1.3.2 System access restriction (Appendix A, Table A-I, FOW System Message, value 0-6). System access restriction, an attribute set at the control station, limits contention ROW transmissions during heavy traffic periods. System access restriction is the minimum precedence for service requests originating at any terminal in the network. A terminal shall not transmit a service request if the precedence is less than the system access restriction.

5.4.2.1.3.3 System service restriction (Appendix A, Table A-I, FOW System Message, value 7-8). The system service restriction is specified in a FOW system message. When the FOW system service restriction is on, a terminal shall not originate requests for 2400-bps circuit services on 5-kHz DAMA channels. Terminals may request 2400-bps voice and data services on single-access channels when the system service restriction is on. Implementation and removal of the system service restriction will not affect ongoing services, except for normal preemption and queuing delays.

5.4.2.1.4 Authorization. A terminal shall not transmit except as permitted in this standard and authorized by the PCC. The control station operator can update the authorization status of any node address. Logged-in network participants whose address authorization changes from authorized to unauthorized are automatically logged out of the network.

5.4.2.1.5 Network login

5.4.2.1.5.1 Terminal login. A terminal shall prohibit any type of transmission other than ranging and login until it receives a positive login acknowledgment. A terminal may log in following acquisition of the downlink and uplink and determination of its link quality to within ±2 dB (see 5.3). The terminal shall report its link quality in the ROW:Login message. The terminal shall identify in the ROW:Login message whether or not it is capable of channel reassignment to (1) a single-access channel, as specified in MIL-STD-188-181, within one frame (8.96 seconds); (2) another 5-kHz TDMA channel, as specified in this standard, within 90 seconds; and (3) a 25-kHz TDMA channel, as specified in MIL-STD-188-183, within 90 seconds. This capability is noted using the Automatic Frequency Change Capability field of the ROW:Login message. A terminal shall select a random time to transmit a ROW:Login message in the contention portion of the ROW. The random time shall be selected as specified in 5.4.2.1.7.4.1. If the login message is received correctly, the PCC sends a FOW:Login Response message to the requesting terminal. Once the terminal receives a positive login acknowledgment, the terminal may participate in the network. A terminal that has logged in and received a positive login acknowledgment shall ignore any subsequent FOW:Login Response messages. If the terminal does not receive a login response in the FOW within the time specified in 5.4.2.1.5.2.2, it shall retransmit the message using the ROW acknowledgment/retry protocol defined in 5.4.2.1.7.4.2. For terminal login only, the terminal may retransmit the message using the acknowledgment/ retry protocol until login is accomplished. Silent terminals may be logged in by the control station operator.

5.4.2.1.5.2 Orderwire message acknowledgment

5.4.2.1.5.2.1 FOW message acknowledgment. The terminal shall acknowledge specific FOW messages as required in Table X. Terminals logged in as silent terminals are not obligated to respond to these FOW messages. ROW messages responding to these FOW messages shall be transmitted within assigned-ROW time slots.

5.4.2.1.5.2.2 ROW message acknowledgment. A terminal sending a ROW message in a contention time slot should expect a FOW acknowledgment message (see Table XI). If no acknowledgment is received within four frames, the terminal shall use the acknowledgment/retry protocol specified in 5.4.2.1.7.4.2 to retransmit the ROW message. If no acknowledgment is received within four frames after retransmission, the terminal shall terminate the orderwire message retransmission attempt. Further orderwire message retransmission attempts must be initiated by the terminal operator, except for terminal login messages described in 5.4.2.1.5.1.

5.4.2.1.6 Network management

5.4.2.1.6.1 Terminal logout. Whenever possible, a terminal shall log out by transmitting a ROW:Logout message in a contention time slot. The terminal shall follow the protocol specified in 5.4.2.1.7.4. If a logout response is not received, the terminal shall terminate the logout protocol and consider itself logged out of the network.

5.4.2.1.6.2 Automatic logout. A terminal is logged out, and shall not participate in the network, whenever a FOW:Logout Response message is received. An automatic logout occurs under any of the following circumstances:

a. The PCC changes the terminal address from authorized to unauthorized.

b. The PCC does not permit a node address to be duplicated in terminal guard lists. If this occurs, the PCC logs out the most recently logged-in terminal that has a duplicate node address.

c. The terminal does not respond to any of four consecutive FOW:Report Status messages and has not logged in as a silent terminal.

5.4.2.1.6.3 Queued service requests. Service requests that are queued are either blocked or pending. A service is considered blocked when its assignment requires the completion of another service or operation, that is, the source or destination is busy. A service becomes unblocked, either pending or active, when the blocking condition clears. A service is considered pending when it is not blocked, but it has not been assigned communications resources. This condition can occur when other services, such as equal or higher-precedence services or preassigned circuits, have been assigned all available communications resources. The PCC does not report blocked or pending status to the terminal. The PCC does, however, report queued status to the terminal in the FOW:Circuit Setup Response or FOW:Message Setup Response message.

5.4.2.1.6.4 Queue maintenance. The PCC manages and maintains all service requests. The PCC processes demand-assigned service requests on a first-in, first-out (FIFO) basis within a precedence category.

a. Pending and blocked service request queue maintenance. For each requested service, the PCC maintains a timer whose duration is 805 frames (approximately 2 hours) for local services and 1342 frames (approximately 3.3 hours) for multiple-hop services. The terminal should maintain similar timers. The PCC deletes from its queue the requests held at the PCC that have not been allocated resources prior to PCC timer expiration. The PCC notifies the source terminal of the service termination and the reason for termination. If the requesting terminal does not receive an assignment or a teardown for a service prior to the expiration of the terminal's timer, the terminal should consider the service torn down.

b. Preempted service queue maintenance. The PCC also maintains a timer on a preempted service. The duration of this timer is 38 frames (approximately 6 minutes) for a local service and 53 frames (approximately 8 minutes) for a multiple-hop service. If the PCC's timer for a preempted service expires prior to resumption of assignment of channel resources to that service, the PCC tears down the service. The PCC notifies the source terminal of the teardown and the reason for the teardown. On receipt of the teardown, the terminal shall inform the operator that the service has been torn down by the PCC. It is possible that the terminal could miss the notifications of torn-down services. Therefore, it is recommended that the terminal maintain similar timers (as defined in the terminal specifications) for its preempted services.

5.4.2.1.7 Frame segment allocation

5.4.2.1.7.1 Forward orderwire resource assignment. The quantity of channel resources allocated to the FOW for a given frame is determined one frame in advance and is transmitted to each network member in the Length of Next FOW field in each FOW. Adaptive techniques are used to determine the allocation of channel resources, based on whether the previous allocation was inadequate, adequate, or excessive for FOW messages to be transmitted.

5.4.2.1.7.2 Communications service assignment. The PCC removes communications service requests from the top of the queue (oldest in the queue) and assigns resources until the COM segment of the frame is full or until there are no more queued requests. Communications assignments are transmitted to the terminal in the FOW. The assignment process may result in assigned time slots for a service in different positions within a frame from one frame to the next. Time slot position shall be determined by the terminal. Time slot position could be determined from the ordering of assignments in the FOW burst. Communications time slots are assigned in reverse order, that is, from the latest (last) to the earliest (first). More specifically, the service receiving the first time-slot assignment in the FOW is assigned to the last time slot in the communications segment of the next frame, the second in the second to last, and so on. For digital voice circuit service, the modulation rate and error correction coding rate will not change from that of the initial circuit assignment.

At most, one 2400-bps voice circuit-service is assigned in any frame. If the voice circuit-service is half-duplex, the circuit-service is assigned only to the last time slot in the frame's COM segment. If the voice circuit-service is full-duplex, two time slots are assigned within one frame. The first is assigned to the last time slot in the frame and the second to a time slot that never changes position after initial assignment.

For the full-duplex service the direction of communications for each of the two slots, as indicated in the Duplex field of the FOW:Circuit Assignment messages, will not be interchanged while the service is active.

5.4.2.1.7.3 Return orderwire resource assignment. The ROW segment contains three sequential sections: contention ranging, assigned, and contention message time slots (see Figure 4). The assigned time slots are used for both ranging and ROW messages, and are assigned by the PCC in the FOW. The position of a time-slot assignment in the ROW segment is based on the ordering of assignments in the FOW burst. ROW time slots are assigned from the earliest-assigned time slot available in the ROW segment to the latest. Thus, the terminal receiving the first ROW assignment in the FOW shall transmit during the first assigned time slot available in the ROW segment (following the contention-ranging time slots), the second in the next, and so on.

5.4.2.1.7.4 Protocol for contention ROW message. A terminal shall identify the beginning of contention time slots in the ROW segment. The beginning could be identified by analyzing the Length of Next FOW field and FOW directed messages that assign ROW capacity. All channel time from immediately following the end of the assigned time slots (determined by parsing the FOW), and preceding the assigned-COM time slots (also determined by parsing FOW directed messages), is available for contention time slots. This remaining time (measured in building blocks) is divided by 17 to provide the number of contention message time slots available in the ROW segment. These contention message time slots shall immediately follow the assigned time slots.

5.4.2.1.7.4.1 Initial transmission of contention ROW message. Any frame may be used for initial transmission of a contention ROW. The contention time slot within the ROW segment shall be selected at random, based on a uniform distribution over the contention time slots within the ROW segment.

5.4.2.1.7.4.2 ROW acknowledgment/retry protocol. This protocol is used for the selection of a single automatic retry to retransmit a contention-ROW message. Further retries shall not be automatic (will require operator intervention). Multiple automatic retries are allowed only for terminal login messages, as described in 5.4.2.1.5.1. Terminals transmitting a contention-ROW message shall expect to receive a FOW response. Terminals that do not receive a response within the time specified in 5.4.2.1.5.2.2, should assume that the ROW message was not received by the PCC. The contention time slot in which to retransmit the ROW message shall be selected using an algorithm that uses two levels of randomization. The first level determines the frame in which to retransmit the contention ROW message. The second level determines the contention time slot to retransmit the ROW message. The contention time slot selection process shall be as follows:

a. Frame identification. To determine the frame in which to retransmit the ROW message, the terminal uses the contention backoff number most recently transmitted by the PCC (in a FOW system message). The terminal derives a uniformly distributed random number, *U1,* between 1 and the contention backoff number, inclusive. Starting at the next frame, the terminal determines the accumulated number of contention message time slots. The frame in which the accumulated number equals or exceeds *U1* is the frame for retransmission of the ROW message.

b. Time-slot identification. To determine the contention-ROW time slot in which to retransmit the ROW message, the terminal derives a uniformly distributed random number, *U2,* between 1 and the number of contention-ROW time slots, inclusive, in the frame determined in a, above. The terminal uses the time slot *U2* for retransmission of the ROW message.

5.4.2.1.7.5 Contention reporting. The terminal has two methods of reporting its success in receiving acknowledgments to contention-ROW messages. One method is in a contention ROW using the Retry Flag; the other is in an assigned ROW using the Retransmission Flag, as indicated below:

a. Within a contention-ROW message, the terminal shall use the Retry Flag field to indicate if the transmission is a first attempt or a retry.

b. Within an assigned-ROW message, the terminal shall use the Retransmission Flag field to indicate if the last contention-ROW transmission was successful.

The terminal shall maintain an internal retransmission flag to indicate if the contention-ROW message most recently transmitted was acknowledged. The terminal shall set the internal retransmission flag to binary 1 if a response to a retransmitted contention ROW is not received within four frames. The terminal shall set the internal retransmission flag to binary 0 if (1) it receives a response to a contention ROW, (2) it detects a change in the ROW backoff number received in the FOW, or (3) 30 minutes has elapsed since the internal retransmission flag was set to binary 1. In any assigned ROW message, the terminal shall set the Retransmission Flag field to the value of the internal retransmission flag. The PCC uses this Retransmission Flag and Retry Flag field information to compute the ROW backoff number.

5.4.2.2 TDMA circuit service

5.4.2.2.1 Circuit service setup. To originate a circuit service, the terminal shall transmit a ROW:Circuit Setup message. In response to the request, the PCC sends either a FOW assignment message (FOW:Circuit Assignment, FOW:Multiple-Hop Circuit Assignment, or FOW:Terminal Channel Assignment message) that establishes the service or a FOW:Circuit Setup Response message, which indicates the request is in the queue or explains the denial of service. If a response is received, the terminal shall abort the ROW acknowledgment/retry protocol.

5.4.2.2.2 Circuit service management. For each queued circuit service, the PCC determines the number of building blocks required, the modulation rate, and the FEC code rate. This determination is a function of (1) whether the communications service is voice or data, (2) whether the service is full- or half-duplex, (3) the I/O data rate, and (4) the end-to-end link quality, as identified in Table IV. For each assigned circuit service, the PCC transmits a FOW:Circuit Assignment message or FOW:Multiple-Hop Circuit Assignment message that specifies (1) whether the communications service is voice or data, (2) whether the service is full- or half-duplex, (3) the I/O data rate, (4) the modulation rate, (5) the FEC code rate, and (6) if a voice service, whether the fixed-voice or subframed-voice format is to be used. The terminals can determine the time-slot size (number of building blocks required) for a circuit service from this information, using the information shown in Table IV. For a full-duplex service, the PCC assigns two COM time slots in the same frame.

5.4.2.2.3 Buffer requirements imposed by clock differences. To account for clock differences at the transmitting terminal, CC, receiving terminal, and I/O devices, data buffers may be required in the terminal. If the receiving terminal transfers data to and the transmitting terminal transfers data from the I/O device at a rate that tracks the rate at which data is transferred within the TDMA frame, no buffer requirement is imposed by the clock differences. If the receiving terminal transfers data to the I/O device at a fixed rate based on the terminal's or I/O device's internal clock, then a receive buffer is required. Likewise, if the transmitting terminal transfers data from the input/output device at a fixed rate, based on the terminal's or I/O device's internal clock, then a transmit buffer is required. Sufficient buffering in the terminal shall be provided to accommodate at least 1 hour for voice and 24 hours for data with continuous operation (bursts in each frame) at an I/O rate of 2400 bps. CC clock accuracy will be 5×10^{-8} or better. Terminal clock accuracy shall be 1×10^{-6} or better.

5.4.2.2.4 Circuit burst formats for synchronous communications. The PCC can assign voice circuit service as either; (1) fixed-voice burst format that provides interoperability with terminals compliant with MIL-STD-188-182 or (2) subframed-voice burst format that has short throughput delay but is not interoperable with terminals compliant with MIL-STD-188-182. The size of the data field in each transmission burst, with the possible exception of the first burst and last two bursts, shall be *N* bits as shown in Table XIV.

TABLE XIV. Size of the User Data field for circuit service.

DATA RATE (bps)	NOMINAL DATA *N* (bits)
75	672
300	2,688
600	5,376
1,200	10,752
2,400	21,504

5.4.2.2.4.1 Circuit burst format for data and fixed-voice services. The burst formats for data and fixed-voice circuit services are shown on Figure 8. All bursts shall start at the beginning of the time slot. In all but the last two bursts the number of user baseband data bits in the User Data field shall be *N*. The last two bursts may contain fewer than *N* data bits. This is required to handle transmission lengths that are not an integral multiple of the nominal User Data field size. Each burst includes an 8-bit Circuit Burst Kind (CBK) field to identify the format of the communications burst and to indicate the first, second from last, and last bursts of a transmission (see Figure 8). The CBK is also a function of whether the circuit is data or fixed-voice. The receiving terminal shall correctly interpret the CBK if no more than 2 bit positions of the 8-bit CBK are received in error.

a. Fixed-voice burst formats. All fixed-voice bursts, except the first and last of a transmission, shall use the Normal Burst (Data or Fixed-Voice) format shown on Figure 8. The first burst shall use the First Burst (Data or Fixed-Voice) burst format shown on Figure 8, unless an entire transmission has N or fewer data bits. When the entire transmission has no more than N data bits, then the Last Burst (Fixed-Voice) format shown on Figure 8 shall be used in the first and only burst of the transmission. The last burst for fixed-voice shall always use the Last Burst (Fixed-Voice) format shown on Figure 8. Unused bits in the Data subfield shall be filled with the repeating 4-bit sequence 1001.

b. Data burst formats. All bursts except the first, second from last, and last burst of data transmissions shall use the Normal Burst (Data or Fixed-Voice) format shown on Figure 8. The first burst shall use the First Burst (Data or Fixed-Voice)

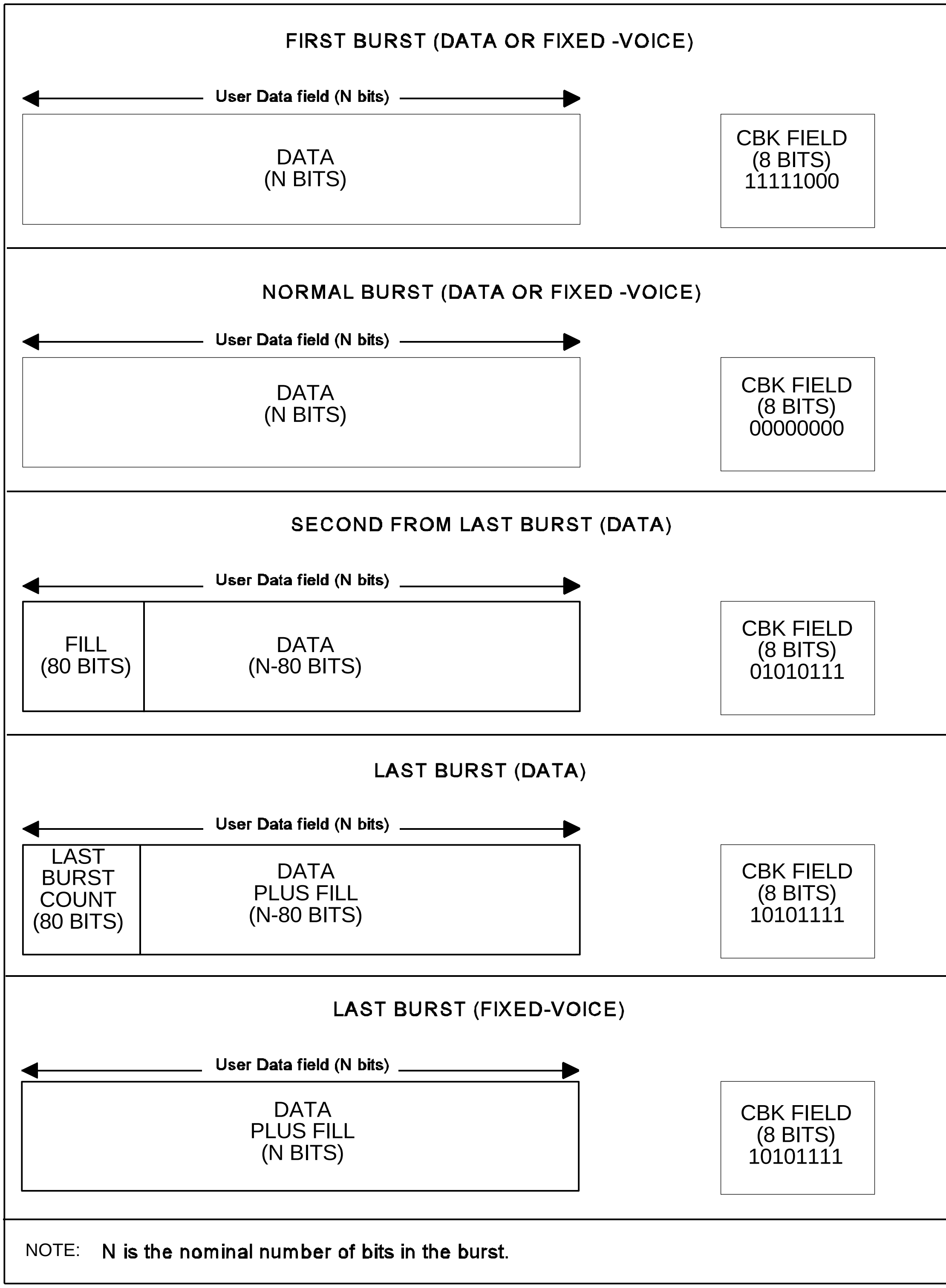


FIGURE 8. Circuit-service burst formats for synchronous communications.

format shown on Figure 8, unless an entire transmission has fewer than *N* data bits. If the entire transmission has *N*-80 or fewer data bits, only the Last Burst (Data) format shown on Figure 8 shall be used. When the entire transmission has fewer than *N* data bits but more than *N*-80 data bits, then the Second From Last Burst (Data) format shall be used for the first burst of the transmission and the Last Burst (Data) format shall be used for the last burst of the transmission. The Second From Last Burst (Data) format shown on Figure 8 shall be used only if the remaining number of data bits is too small to fill a Normal Burst (Data or Fixed-Voice) format (fewer than *N bits*) and too large to fit into the Last Burst (Data) format (greater than *N*-80 bits). The 80-bit Fill subfield shall contain the repeating 4-bit sequence 1001. The Data subfield shall contain *N*-80 bits. The format for the last burst contains an 80-bit Last Burst Count subfield. The maximum number of non-fill bits that may be transmitted in the last burst is *N*-80 bits. Unused bits in the Data plus Fill subfields shall be filled with the repeating 4-bit sequence 1001. The Last Burst Count subfield shall contain a count of the number of non-fill data bits in the burst. The count shall consist of a 16-bit binary number repeated 5 times to fill the 80-bit Last Burst Count subfield. Each time the 16-bit number is repeated, the most significant bit (MSB) shall be transmitted first. The receiving terminal shall correctly interpret the Last Burst Count subfield if no more than 2 of the 16-bit binary numbers are received in error.

5.4.2.2.4.2 Circuit burst formats for subframed-voice services. The burst formats for subframed-voice circuit services allow for shorter throughput delays and are shown on Figure 9. All transmission bursts other than the first and the last shall use the Normal Burst format shown on Figure 9 and end within the allocated guard time at the end of the time slot. The first burst for a transmission may contain pre-fill bits and may start after the start of a time slot. The last burst may end before the end of a time slot. In all but the first and last bursts, the size of the User Data field shall be *N* as given in Table XIV for 2400 bps. The first and last burst User Data field may contain fewer than *N* data bits. This is required to handle transmission lengths that are not an integer multiple of the User Data field size, and to allow for shorter throughput delays by accommodating (1) the first burst to start after the start of a time slot and (2) the last burst to end before the end of the time slot. Each burst, except the Type A Last Burst format shown on Figure 9, includes a Circuit Burst Kind (CBK) field to identify the format of the burst. The last burst, if it ends before the end of a time slot, includes an Over Code as described in subparagraph b and does not include a CBK field. The receiving terminal shall correctly interpret the CBK if no more than two bit positions of the 8-bit CBK are received in error.

a. Burst starting at middle of time slot. Unless an entire transmission can be sent within a single burst, the First Burst format, shown on Figure 9, shall be used for the first

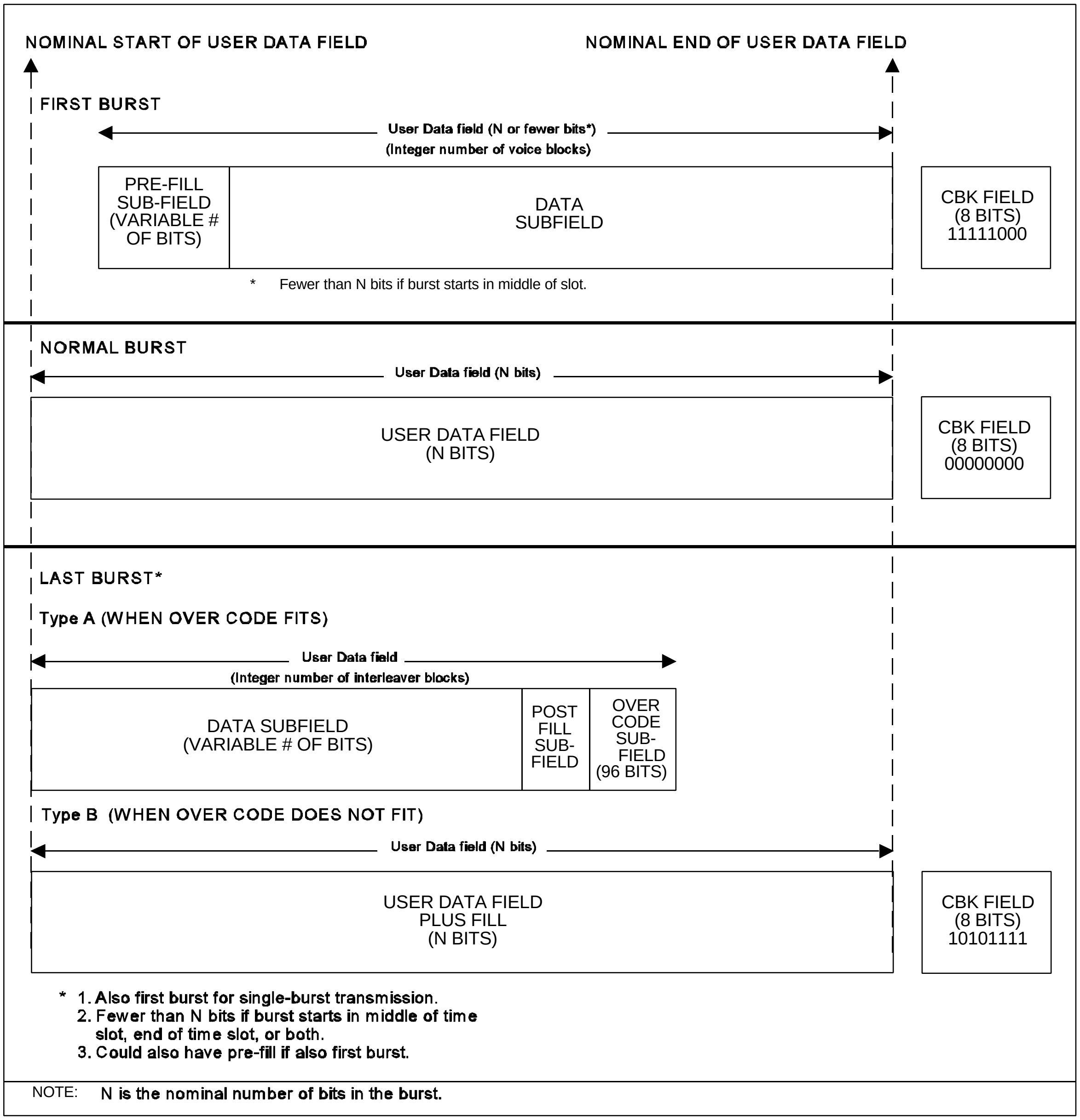


FIGURE 9. Circuit service burst formats for subframed voice.

burst. If the entire transmission can be sent within a single burst, one of the two Last Burst formats shown on Figure 9 shall be used. To minimize the throughput delays the terminal can start the first burst after the beginning of the time slot and can use pre-fill bits in the first burst. If pre-fill bits are used, they shall be repeated hexadecimal 99 bytes, and there should be as little pre-fill as possible. The first burst User

Data field shall have an integer number of voice blocks. The term voice-block is used to represent a block of 448 over-the-air bits, whether or not the burst is FEC encoded. Transmission shall begin at any delay point of the time slot sufficient to transmit the integer number of voice blocks and end at the end of the time slot. Each time slot can have 0, 1, 2, ..., up to N_{blk}-1 voice blocks, where N_{blk} is the number of voice blocks in a completely filled slot. For R = 7/8, N_{blk} is not an integer (N_{blk} = ((21504)/(7/8))/448 = 54.857). Therefore, the last (55th) voice block shall contain 384 coded voice bits followed by 64 fill bits having the pattern 10011001..., resulting in a full voice block having 448 over-the-air bits.

b. Burst ending at middle of time slot. The last burst of a subframed voice transmission that finishes with fewer than 96 bits from the end of the time-slot shall post-fill with sufficient hexadecimal 99 bytes and use the Last Burst format Type B that includes the CBK field. The last burst of a subframed voice transmission that finishes 96 bits or more from the end of the time-slot shall use the Last Burst format Type A which includes the 96-bit Over Code subfield and then post-fill bits before the Over Code to fill the last interleaver block. The Over Code is used to signal the availability of the channel and shall be the hexadecimal value F134F134 repeated three times. Each time the Over Code sequence is repeated, the most significant bit of F shall be transmitted first. The Over Code shall be appended to the transmit user data stream. Receiving terminals search the demodulated, and decoded (if required) data stream for the Over Code. The receiving terminal shall correctly interpret the Over Code subfield if any 32-bit F134F134 sequence of the 96-bit subfield is received without errors. Upon receipt of either a last burst CBK or Over Code, a receiving terminal shall be capable of initiating burst transmissions.

c. Single burst transmissions. When the entire transmission requires only a single burst, then one of the two last burst formats shall be used. A single burst transmission can start at the middle of the time slot and end before or at the end of the time slot. If the burst will end with fewer than 96 bits from the end of the time-slot, then the Last Burst Type B format shall be used in the first and only burst of the transmission. When the entire transmission ends 96 bits or more from the end of the time-slot, then the Last Burst Type A format shall be used in the first and the only burst of the transmission.

d. TDMA throughput delay for voice. The time from the input of a user data bit (encrypted, if applicable) to a terminal for transmission until that user bit is output from another terminal is called the TDMA throughput delay. For subframed-voice service, the TDMA throughput delay shall not exceed the maximum TDMA throughput delay given in Table XV.

TABLE XV. TDMA throughput delay for subframed voice.

BURST RATE (sps)	FEC CODE RATE	MAXIMUM TDMA THROUGHPUT DELAY (seconds)
3000	1/2	2.02
2400	3/4	3.25
3000	3/4	4.41
3000	7/8	5.10
3000	1	5.60

NOTE: Delay does not include satellite propagation delay

5.4.2.2.5 Circuit burst format for asynchronous communications. When communications terminals are used to communicate off-line encrypted data, the interfacing I/O equipment typically uses asynchronous data communications. For interfacing with asynchronous I/O equipment, the transmitting terminal shall strip any start, stop, or parity bits, if not encrypted, and the receiving terminal shall put these bits back onto the data stream. Therefore, the over-the-air data rate is always below the user I/O data rate.

Each burst includes an 8-bit CBK field (see Figure 10). The CBK field shall be 11111000 for the first burst of the transmission, 00000000 for all but the first and last burst of the transmission, and 10101111 for the last burst. The receiving terminal shall correctly interpret the CBK if no more than 2 bit positions of the 8-bit CBK are received in error. When the entire transmission has no more than N-80 data bits, the last burst CBK format shall be used in the first and only burst of the transmission. Unused bits in the data subfield shall be filled with the repeating 4-bit sequence 1001. The Burst Count subfield shall contain a count of the number of non-fill data bits in the burst. The count shall consist of a 16-bit binary number repeated 5 times to fill the 80-bit Burst Count subfield. Each time the 16-bit number is repeated, the MSB shall be transmitted first. The receiving terminal shall correctly interpret the Burst Count subfield if no more than 2 of the 16-bit binary numbers are received in error.

5.4.2.2.6 Circuit service teardown. The PCC tears down a circuit service under the following circumstances:

a. a ROW:Circuit Teardown or ROW:Multiple-Hop Circuit Teardown (ACC only) message is received,

b. an End-of-Service indicator is detected in the Burst Type field of the assigned-communications time slot,

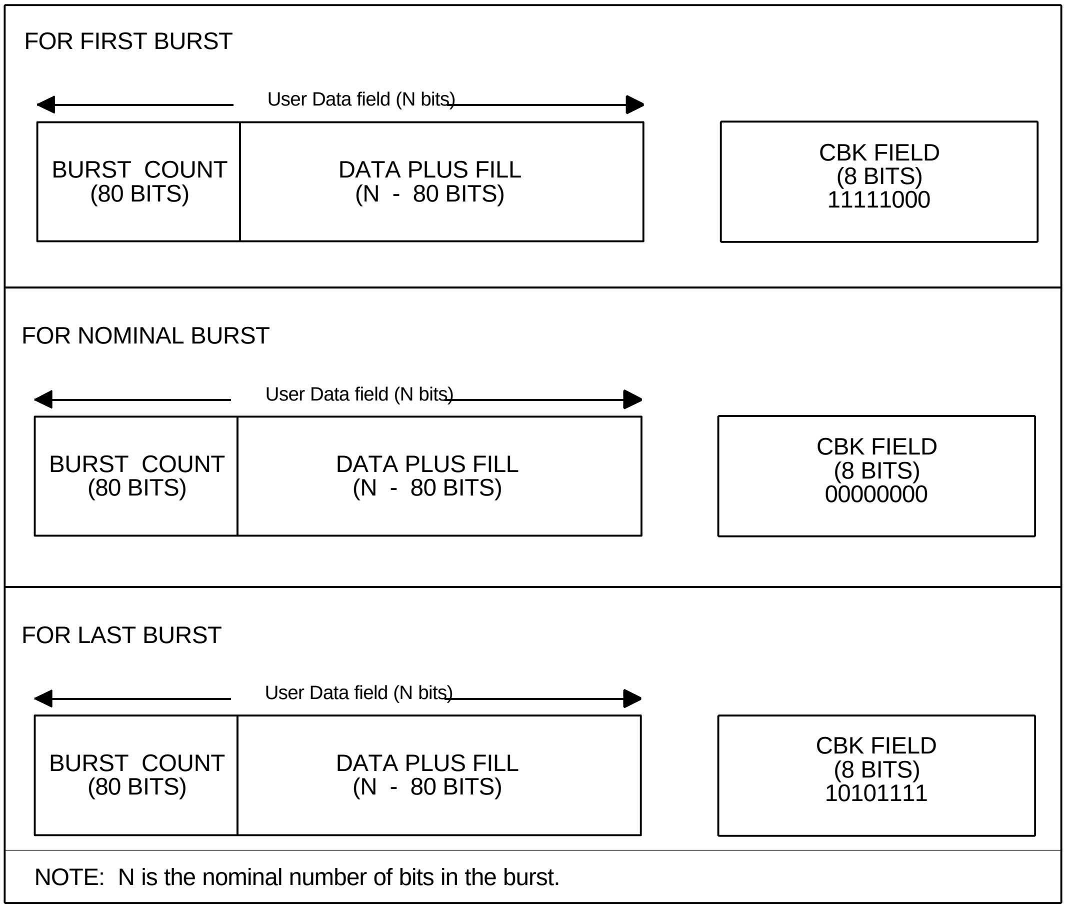


FIGURE 10. Circuit-service field formats for asynchronous communications.

c. a control station operator teardown command is applied,

d. a service preemption timer expires, or

e. a service queuing delay timer expires.

On teardown, the PCC sends a FOW:Circuit Teardown or FOW:Multiple-Hop Service Teardown message (ACC only) to notify the terminals in the service. These two messages include the reason for service teardown. When the teardown command is received, terminals shall cease transmission pertaining to that service in the frame following the one in which the teardown in received.

5.4.2.3 TDMA message service. Message service may be global or local. Global message service is accomplished by using control stations to relay the message across intermediate footprints. Within any footprint the message is completely transferred to the relaying PCC, with the relaying PCC mediating the transfer, before passing the message on to the control station in the adjoining footprint. When a message has reached the destination terminal and has been successfully transferred to the terminal's I/O device, ROWs and FOWs are transmitted back along the path to the source terminal tearing down the service and providing a positive acknowledgment of message delivery. If the message transfer fails for any reason, the teardown process will provide a non-acknowledgment to advise that the message was not delivered. Paragraphs 5.4.2.3.1 through 5.4.2.3.4 describe the protocol for local message service. The protocol applies also to message transfer in any footprint for global service.

5.4.2.3.1 Message service setup. To originate a message service, the terminal shall transmit a ROW:Message Setup message. In response to the request, the PCC sends either a FOW:Message Assignment message that establishes the service or a FOW:Message Setup Response message that informs the terminal that the request is in queue or explains the denial of service. If the terminal receives a response, the terminal shall abort the ROW acknowledgment/retry protocol.

5.4.2.3.2 Message service management. Message information transmitted over the channel shall be arranged into packets. A data block containing 224 message bits shall be the minimum packet size. However, the last block in a message can have fill bytes. A separate communications burst is used to transmit each packet, and a FOW:Message Assignment message is used for each assigned communications burst.

a. Packet transmission within frame. The PCC directs the source terminal to transmit one or more packets in each frame. Multiple packets for the same service are not assigned to be transmitted during the same frame unless all other services in the queue have been considered for scheduling.

b. Packet parameter options. For a queued message service, the PCC determines the number of 224-bit data blocks to be transmitted in a burst, the number of building blocks required, the modulation rate, and the FEC code rate. This determination is a function of (1) the end-to-end link quality, (2) the number of blocks remaining to be transmitted, and (3) the available communications resources (see Table V). The number of blocks remaining to be transmitted is known by the PCC because the message length is indicated in the ROW:Message Setup message. For each assigned message service, the PCC specifies the modulation rate, FEC code rate, and number of data blocks in the FOW:Message Assignment message. The terminal shall determine the time-slot size (number of building blocks required) for a message service from this information, as shown in Table V.

5.4.2.3.2.1 Block status polling. For a point-to-point message service, the PCC polls the destination terminal after packet transmissions to determine which blocks have been correctly received. Polling occurs by transmission of a FOW:Acknowledge Blocks message. If the PCC does not poll the destination terminal after a given packet transmission, the PCC continues to direct transmission of the packets until able to poll.

5.4.2.3.2.2 Block acknowledgments. Block acknowledgment is used with point-to-point message services to acknowledge the block up to which all blocks have been received correctly at the time of the ROW:Blocks Acknowledgment message transmission. When polled by the PCC with the FOW:Acknowledge Blocks message, the terminal shall respond with a ROW:Blocks Acknowledgment message. If additional blocks remain to be transmitted following receipt of the ROW:Blocks Acknowledgment message, the PCC will direct the transmission of one or more of these blocks beginning with the block following the last acknowledged block. This procedure continues until all message data has been transmitted and acknowledged, or until the service is torn down. If the PCC does not receive a ROW:Blocks Acknowledgment message in response to its poll, the PCC continues to poll the destination terminal while directing sequential transmission of the data blocks.

5.4.2.3.2.3 Point-to-point message processing. If the PCC determines from the ROW:Blocks Acknowledgment message that the destination terminal still did not receive a particular data block after retransmission, the PCC increases the robustness of the service's burst code (that is, moves up one line in Table V). For a message service, the burst code is a combination of modulation rate, coding rate, and maximum burst size, corresponding to a line in Table V. The PCC directs up to two retransmissions of the message data, beginning at the data block in error. If the destination terminal still does not acknowledge receipt of the message data, the PCC again increases the robustness of the burst code and directs, at most, two more retransmissions of the message data. This procedure repeats until either the destination terminal acknowledges correct receipt of all transmitted data blocks or the most robust burst code has been reached. Once the most robust burst code has been reached, the PCC no longer directs block acknowledgments or a final message acknowledgment.

5.4.2.3.2.4 Subnet message processing. For subnet message services, the PCC directs the source terminal to transmit the blocks sequentially. The PCC does not poll the destination terminals for acknowledgments. The service is torn down when the source terminal has completed transmission of the last data block or when a teardown request is received.

5.4.2.3.2.5 Unused-byte counter. All packets, except the last, contain an integer number of data blocks of valid message data. The last packet also contains an integer number of data blocks, but the data blocks can contain both valid message data and fill bytes. The last packet shall use the unused-byte counter to identify the number of fill bytes that follow valid data bytes in the packet. Each fill byte shall have the pattern 10011001. These fill bytes shall be removed by the receiving terminal. The size of the last packet is the smallest packet that satisfies the link conditions and whose size exceeds the remaining number of data blocks. If completely filled with valid message data, the last packet will contain no fill bytes.

5.4.2.3.2.6 Message acknowledgment. The PCC assigns a ROW time slot to the destination terminal for transmission of a message acknowledgment, following the positive acknowledgment of the last data block. This assignment is made by transmission of a FOW:Acknowledge Message message. The earliest the ROW time slot is assigned is in the Nth frame from the frame in which the last block acknowledgment was received, where N will be calculated as follows:

$$N = \text{integer}\ [(\text{message length} / \text{I/O device rate}) / 8.96\ \text{sec}\ ] + 1$$

where message length is in bits and I/O device rate is in bps.

a. I/O data rate determination. When multiple I/O device rates are stored at the PCC for the destination terminal, the PCC assumes that messages are always output at the highest rate.

b. Message acknowledgment. The receiving terminal shall send a ROW:Message Acknowledgment message only after the terminal has successfully delivered the message to the terminal I/O device. The terminal specification should define if the message is to be delivered to the I/O device after the message has been completely and correctly received, or incrementally as continuous blocks are correctly received. When the PCC receives a ROW:Message Acknowledgment message from the destination terminal, it transmits a FOW:Message Acknowledgment message, with the Acknowledgment Type field set to binary 1, to notify the source terminal of the acknowledgment.

c. Acknowledge receipt of blocks. The PCC may send a FOW:Message Acknowledgment message, with the Acknowledgment Type field set to binary 0, to a source terminal when the destination terminal acknowledges all blocks in a message. This makes the source terminal available for other services while the destination terminal is attempting to transfer the message to its I/O device. The source terminal shall not reuse the virtual port number in follow-on service requests until the service is torn down.

5.4.2.3.3 Message-service teardown. The PCC terminates channel resource assignments for message services when they are no longer required. For a point-to-point message service, if all message data is transmitted and acknowledged and a ROW:Message Acknowledgment message is received from the destination terminal, the FOW:Message Acknowledgment message sent by the PCC, with the Acknowledgment Type field set to binary 1, serves as a teardown notification. The PCC otherwise sends an explicit FOW:Message Teardown message, which indicates the reason for teardown. The terminal shall implement the FOW:Message Teardown message in the frame following the one in which the teardown is received. The PCC sends a FOW:Message Teardown message under the following circumstances:

a. message service is complete (that is, all data blocks have been assigned transmission time slots) but not all blocks were acknowledged, such as for subnet services;

b. point-to-point message service is complete but message acknowledgment was not received from the destination terminal;

c. a ROW:Message Teardown message is received;

d. an End-of-Service indicator is detected in the Burst Type field of the assigned-communications time slot;

e. a control station operator teardown command is applied;

f. a service preemption timer expires; or

g. a service queuing delay timer expires.

5.4.2.3.4 Terminal busy status. The PCC considers a subnet service not busy in the frame following the assignment of channel capacity for the last packet. The PCC considers terminals involved in a point-to-point message service not busy in the following frame when:

a. the PCC receives the message acknowledgment,

b. the PCC fails to receive an acknowledgment following the second request for message acknowledgment,

c. the last data block of a non-acknowledged delivery is transmitted, or

d. the PCC transmits a FOW:Message Acknowledgment message indicating all blocks acknowledged.

5.4.2.4 DASA channel service

5.4.2.4.1 Terminal requirements. Terminals requesting DASA service shall identify capabilities for DASA channel operations as specified in 5.4.2.1.5.1. Terminals that are operationally constrained from frequency changes shall identify that limitation using the ROW:Login message. Those terminals that are not capable of automatic frequency change shall indicate this limitation in the ROW:Login message when they log into a network, and will not be directed to change channels via the FOW:Terminal Channel Assignment message. Operation on the assigned channel shall be as specified in MIL-STD-188-181.

5.4.2.4.2 Protocol

5.4.2.4.2.1 Channel assignment. Terminals may request an assignment of a DASA channel using a ROW:Circuit Setup message. The single-access channel request includes a channel duration time in minutes. Terminal requests and PCC assignments for a DASA channel include a period of time up to 5115 minutes. The PCC responds with either (a) a FOW:Circuit Setup Response message identifying that the service is queued or identifying the reason for rejecting the service request, or (b) a FOW:Terminal Channel Assignment message assigning the requesting terminal to a single-access channel. If the Channel Type field in the FOW:Terminal Channel Assignment message is set to binary 1, the channel operates in the single-access mode. The terminal shall determine, based on the Channel field and Appendix D, whether the assigned channel is 5- or 25-kHz. When a service is assigned to a single-access channel, the PCC will individually assign members of subnet destinations using separate FOW:Terminal Channel Assignment messages. When a FOW:Terminal Channel Assignment message is sent, a time slot for an assigned-ROW message is reserved and the terminal guarding that node address shall respond with a ROW:Terminal Channel Assignment Response message before switching to the single-access channel. The terminal shall reject any terminal channel assignment which it does not accept, using the ROW:Terminal Channel Assignment Response message.

5.4.2.4.2.2 Service request maintenance. Prior to switching to the DASA channel, the terminal shall tear down any active service. When switching to a DASA channel (5- or 25-kHz) the terminal may retain all pending service requests. The PCC will not increment the queue service timers for retained service requests.

5.4.2.4.2.3 Return to TDMA channel. Terminals shall return to the initial TDMA channel prior to, or immediately after, the assigned time. Upon return to the initial TDMA channel, the terminal shall achieve downlink and uplink synchronization. The PCC will assume that a terminal has achieved downlink and uplink synchronization, and is available for TDMA service assignments, 10 frames after the assigned time. For early return to the TDMA channel the terminal shall send a ROW:Terminal Channel Return message in a contention-ROW-message time slot, if the selected contention-ROW message time slot occurs before the end of the assigned channel time. The PCC responds to a ROW:Terminal Channel Return message with a FOW:Contention Response message.

5.4.2.5 Network management

5.4.2.5.1 Addressing. Sixteen-bit addresses shall be used for identifying network nodes and subnets. A node address identifies a particular point in the network, such as a terminal or a CC. A subnet address identifies a group of terminals, local to one satellite footprint, that have a need for common communications. Each terminal shall receive FOW messages and process those messages directed to its terminal node address or to any other address in its guard list. Each terminal shall maintain a guard list. This guard list shall contain the node and subnet addresses for which the terminal receives services. (See Table XVI.)

TABLE XVI. Guard-list contents.

terminal node address
node/subnet address #1
node/subnet address #2
node/subnet address #3
node/subnet address #4
node/subnet address #5
node/subnet address #6
node/subnet address #7
node/subnet address #8
node/subnet address #9
node/subnet address #10
node/subnet address #11
node/subnet address #12
node/subnet address #13
node/subnet address #14
node/subnet address #15

5.4.2.5.1.1 Node address. A terminal shall always use its unique terminal node address to identify itself in orderwire messages; that is, when logging into the network, requesting services, and in other orderwire messages. Each CC within a control station has one unique CC node address to identify the CC in orderwire messages, including service requests. **Each CC can guard additional addresses, both node and subnet.**

5.4.2.5.1.2 Reserved address. Zero is a reserved address, guarded by the PCC that controls the local network; that is, all traffic addressed to address zero is routed to the PCC. Terminals shall not use address zero for a login address or maintain address zero on their guard lists.

5.4.2.5.1.3 Demarcation of subnet addresses. The address space is partitioned to indicate whether an address is a node or subnet address. Demarcation between node and subnet addresses is set by the control station operator. All addresses with a numeric value greater than the demarcation point are subnet addresses. By default, the demarcation point is 16384: the node addresses occupy addresses 1 through 16384, and the subnet addresses occupy addresses 16385 through 65535. A subnet address shall not be used for a terminal node address. If a login is attempted with a subnet address, the login is rejected and the FOW:Login Response message informs the terminal of the address demarcation problem.

5.4.2.5.2 Guard lists. The guard list contains addresses for up to 15 nodes or subnets, in addition to the terminal node address. Table XVI illustrates the guard-list contents. A terminal shall report the number of addresses on its guard list and a guard list CRC in the ROW:Login message. Only node/subnet addresses shall be counted for the number of addresses to be reported in the ROW:Login message. The terminal node address is not counted. For purposes of guard list reporting and guard list CRC calculation, the terminal shall arrange the order of node/subnet addresses in its guard list in ascending order (see Table XVI), and place binary 0 in all empty address fields at the bottom of the guard list. The 16-bit addresses in the guard list shown in Table XVI form a 256-bit data sequence over which the guard-list CRC is calculated (see 5.4.3.1 b).

a. Guard list reporting. When requested by the PCC in one or more FOW:Report Terminal Address messages, the terminal shall report its guard list of node and subnet addresses in a ROW:Terminal Address Report messages. The terminal node address is not reported in this message.

b. Guard-list content requirements. When reporting guard-list addresses in the ROW:Terminal Address Report message, the terminal shall fill with zeros any fields corresponding to empty locations on the terminal guard list. If the terminal reports an unauthorized address or if the report is not received by the PCC, the PCC may log out the terminal.

c. Guard list updates. The terminal shall update its guard list when requested by the PCC in a FOW:Terminal Address Add or Delete message. The terminal shall respond to the FOW request with a ROW:Terminal Address Add or Delete Response message. The terminal shall always report that an address deletion was successful, whether or not the address was originally in the guard list. The terminal shall report a failure to add an address only if the address is not already on its guard list and the guard list is full. If the terminal is involved in a receive service directed to a deleted address, the terminal shall ignore any further communications associated with the service.

5.4.2.5.3 Service requests and time-slot assignments. The PCC queues up to five service requests from a terminal. Terminals shall identify each service request by a unique service identification number (0-4) known as the terminal virtual port number. The terminal shall not reuse a virtual port number until the initial request with the virtual port number is no longer valid (such as is the case with a rejected request, a received teardown, or a timeout). The terminal shall not use virtual port numbers greater than those permitted.

a. Service assignment restrictions. The terminal shall be capable of processing any assigned services in the sequence established by the PCC, independently of the services requested by the terminal. The terminal will be assigned no more than one point-to-point service, as either the source or destination, at a time. For subnet service, terminals will not be assigned as the source of more than one service at a time. When participating in a point-to-point service, a terminal will not be assigned as the source of a subnet service, and vice versa. Before transmission of a service request, the terminal shall validate the service request against terminal access restrictions, system access restrictions, and system service restrictions.

b. Service processing. The terminal shall be capable of processing at least two active subnet message services as the service destination during a single frame while participating in one other active service of any type (as either the source or the destination). The terminal shall process multiple assignments in the following manner: (1) if the terminal is assigned multiple services that it cannot process simultaneously (for example, both a point-to-point service and a subnet circuit service), it shall process the service with the highest precedence; (2) if the terminal is assigned multiple services at the same precedence level, it shall process the first service assigned and continue to process the service until preempted, completed, or the operator intervenes. If at any time the services assigned are more than what the terminal can process, the terminal may identify to the operator all assigned services and may provide the means for the operator to select which should be processed. Terminal specifications should define the detail requirements of the operator-terminal interface.

5.4.2.5.4 Network transition

5.4.2.5.4.1 PCC transition. Network control transition occurs when responsibility for generating the FOW transitions from one PCC to another. Control transition is indicated in either a FOW:Manual Control Transition Countdown system message (see Table A-I in Appendix A) or by detection of a change of PCC address in subsequent FOWs. Upon detecting a control transition, the terminal can expect to receive a FOW:Participant Status Data Base message that reports the terminal's status being held at the new PCC. A terminal can assume that it will not receive any further FOW:Participant Status Data Base messages if either of the following occurs:

a. a frame is received without a FOW:Participant Status Data Base message, or

b. a FOW:Participant Status Data Base message is received with the End Indicator field set to binary 1.

If a FOW:Participant Status Data Base message addressed to the terminal is not received and the terminal has determined that the PCC has stopped sending FOW:Participant Status Data Base messages after the transition, the terminal shall consider that it is logged out. The terminal specification should define what action the terminal and the operator should take. If a FOW:Participant Status Data Base message that reports the terminal's status is received, and the number of indicated demand-assigned services for which the terminal is the service source (either active or queued) does not agree with the number in the terminal's data base, the terminal shall send a ROW:Circuit Setup or ROW:Message Setup message to the PCC for each demand-assigned service that should be active or queued.

5.4.2.5.4.2 Channel transition. When a FOW system message indicates a single-access channel mode countdown is in progress, the terminal shall comply with the FOW-system message countdown and switch to single access operations in the frame identified by the countdown message (see Table A-I in Appendix A). The terminal is logged out upon switching to single access operations without having to transmit a ROW:Logout message. The terminal specifications should define the detail requirements of operator notification.

5.4.2.5.5 Status report. Terminals shall respond to a FOW:Report Status message from the PCC by transmitting a ROW:Status Report message in the assigned-ROW time slot. If the PCC does not receive a response for four consecutive requests, the terminal is automatically logged out. The PCC does not request status reports from terminals logged in as silent terminals. Upon terminal operator-initiated action, this ROW may be sent in a contention time slot. Contention time slot status reporting shall not be used by operator-initiated action to report: (1) a change in link quality unless the link quality has changed by more than 2 dB from the most recently reported value, or (2) a change in the Retransmission Flag field.

5.4.2.5.6 TDMA service teardown. Terminals shall request teardown of circuit or message service under the conditions specified in this paragraph. However, only the PCC issues a service teardown.

5.4.2.5.6.1 Service teardown request. Terminal teardown requests for all services shall be as specified in this paragraph.

a. Terminals shall automatically request teardown of:

1. any circuit service the terminal originated but will not process upon initial assignment,

2. any message service the terminal originated but will not process,

3. any point-to-point service for which the terminal is the source or destination and which it will not process.

b. Terminals shall not request teardown of:

1. any preassigned service,

2. any service the terminal did not originate and the conditions of 5.4.2.5.6.1 a (3) do not apply.

c. Terminals may request teardown of any active point-to-point circuit service in which they are participating.

5.4.2.5.6.2 Service teardown protocol. For the teardown protocols discussed in 5.4.2.5.6.2.1 and 5.4.2.5.6.2.2, the FOW messages employed can be FOW:Circuit Teardown or FOW:Message Teardown messages as applicable. Also, the ROW messages requesting teardown can be a ROW:Circuit Teardown or a ROW:Message Teardown message as applicable.

5.4.2.5.6.2.1 Active service teardown. The source terminal requesting the service teardown shall transmit the Preamble, SOM sequence, and End-of-Service Burst Type fields in each assigned-communications time slot. The PCC should respond with a FOW:Teardown message. The source terminal shall transmit a ROW:Teardown message in the contention portion of the ROW segment if, after the fourth frame following the frame in which the terminal transmitted the first End-of-Service bit sequence in the Burst Type field, a FOW:Teardown message has not been received. The terminal shall continue to transmit the Preamble and SOM fields and the End-of-Service indicator in the Burst Type field in each assigned-COM time slot until a FOW:Teardown message is received. If the terminal requesting the teardown is a point-to-point service destination terminal, then it shall follow the protocol defined in 5.4.2.5.6.2.2.

5.4.2.5.6.2.2 Queued service teardown. The source terminal requesting teardown shall transmit a ROW:Teardown message. The PCC should respond with a FOW:Teardown message. If the terminal receives no response after the retry protocol (5.4.2.1.7.4.2) has been performed, the terminal shall assume the service has been torn down and the virtual port shall be available for use.

5.4.3 Error control

5.4.3.1 Error detection. Two CRC code lengths are used for error detection. A long code (16 bits) shall be used on FOW transmissions, on message-service data blocks, and as a check of guard-list consistency. A short code (8 bits) shall be used on ROW-message and ROW-ranging transmissions. The 8-bit CRC polynomial is not of the usual CRC form (1 + x)/p(x), where p(x) is a primitive polynomial. Only bursts received correctly, as determined by the CRC, shall be used by the terminal for FOW and ROW-ranging transmissions. For point-to-point message services for which the PCC no longer directs block acknowledgments, and for subnet message services, message data will be output to the terminal's I/O device whether or not the CRC calculations are valid. The generator polynomials for the long and short codes, respectively, shall be as given below:

Generator polynomial for 16-bit CRC:

$$G(x) = x^{16} + x^{12} + x^{5} + 1$$

Generator polynomial for 8-bit CRC:

$$G(x) = x^{8} + x^{7} + x^{6} + x^{3} + 1$$

The data polynomial is:

$$D(x) = a_m x^m + a_{m-1} x^{m-1} + \ldots a_1 x^1 + a_0$$

where

$m + 1$	=	the number of bits over which the CRC is computed
$a_m, a_{m-1}, \ldots a_1, a_0$	=	the bits for which the CRC is computed; a_m is the MSB and is transmitted first

The transmitted CRC shall be equivalent to that obtained by performing the following steps. First, multiply $D(x)$ by x^n, where n is the number of bits in the CRC (8 or 16). Next, perform a polynomial division of $G(x)$ into the product $[x^n D(x)]$ using modulo-2 arithmetic (no carries or borrows). The CRC is the resulting remainder. The CRC bits shall be transmitted MSB (higher order term) first. The trailing zeros that result from the $[x^n D(x)]$ multiplication are not transmitted. (See 6.5).

a. Fill bits. If (m + 1) is not an integer number of bytes (8 bits) in length, then the bit string for which the CRC is computed is extended with zero fill after the last bit to be transmitted, to result in an integer number of bytes. This operation is in addition to the multiplication by x^n. These fill bits are not transmitted.

b. Guard-list CRC consistency. For the check of guard-list consistency, a_m is the MSB of the terminal node address, a_{m-15} is the LSB of the terminal node address, a_{m-16} is the MSB for the first address in the guard list, and so on. All address fields of the 15-address guard list for which there is no guarded address is zero-filled for the CRC calculation, and (m + 1) is 256. All zero fill occurs at the end of the valid guard-list address.

5.4.3.2 Error correction encoding/decoding. For rate 1/2 coding the output of the encoder shall be identical with the output of the rate 1/2, constraint length 7 convolutional encoder shown on Figure 11 and described below. The code tap positions are given below and are also shown on Figure 11. The encoder is initially loaded with all zeros. When the first data bit is shifted into the encoder, the encoder outputs *P1* and *P2* will provide the first and second bits to be transmitted, respectively. A new data bit is then shifted into the encoder (left-most position on Figure 11), and 1 bit (right-most position on Figure 11) is shifted out of the encoder. The encoder outputs *P1* and *P2* then provide the next 2 bits to be transmitted (in the order *P1* followed by *P2*). The process of shifting data into the encoder and taking data from encoder outputs *P1* and *P2* then continues. Following the last data bit, 6 zeros (the Flush field) are shifted into the encoder to produce the last 12 encoded bits.

P1 taps: 1111001
P2 taps: 1011011

5.4.3.2.1 Punctured forward error correction codes. Higher rate 3/4 and 7/8 codes shall be derived from the rate 1/2 code using the puncture pattern shown in Table XVII. Only those bits identified with a 1 in the table are transmitted.

5.4.3.3 Interleaving/deinterleaving. The block interleaving structure shall consist of two independently constructed blocks of 112 bits used in sequence. The interleaving process shall be equivalent to writing input bits into the 112-bit blocks sequentially as shown in the input order

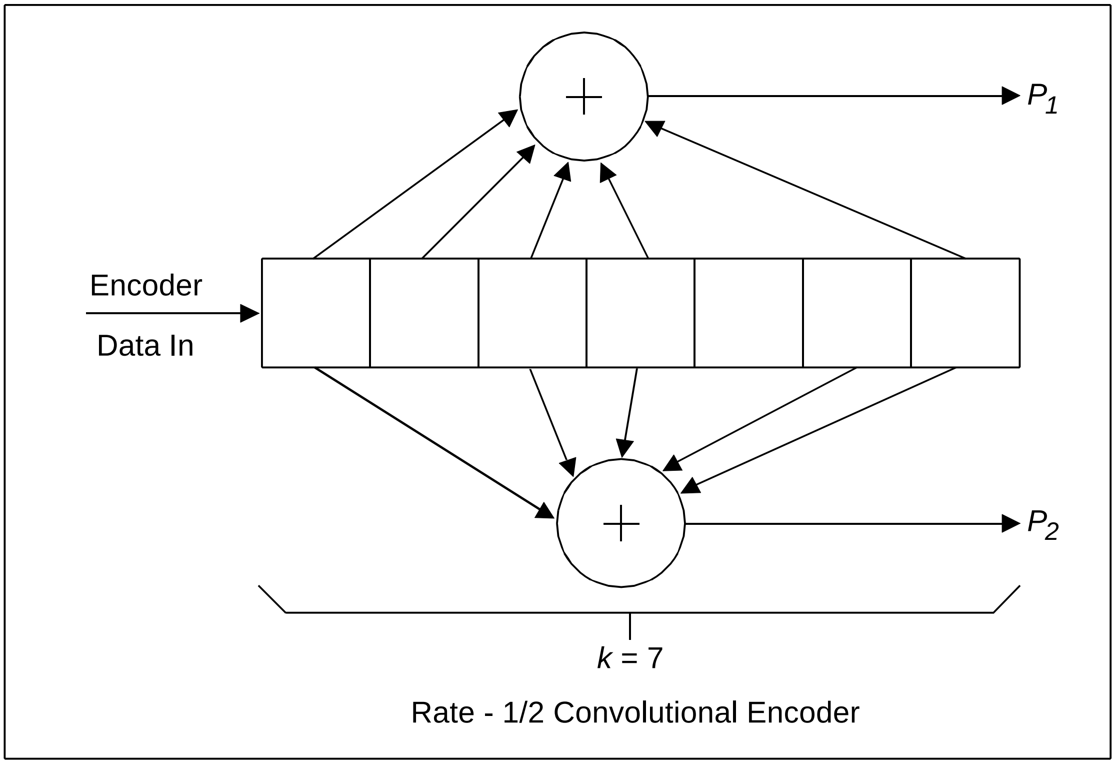


FIGURE 11. Rate 1/2 convolutional encoder.

TABLE XVII. Puncture code pattern.

CODE RATE	SYMBOL	PUNCTURE PATTERN
3/4	C0	101
	C1	110
7/8	C0	1000101
	C1	1111010

columns of Tables XVIII and XIX and read out in the order dictated by the output order columns of the tables. For example, the first three bits written into the interleaver block, input order 0, 1, and 2, are read from the interleaver block as bits 19, 61, and 86. Likewise, the first three bits read from the interleaver, output order 0, 1, and 2, are the bits that were written to the interleaver block in positions 70, 46, and 62. Deinterleaving shall reverse this operation. Interleaver boundaries shall start at the beginning of the User Data field within each burst for circuit services (see Figure 5); they shall start at the beginning of the data block within each packet for message service (see Figure 6), with the first interleaved bit of the burst in the first position defined by the block of Table XVIII. Note that each circuit-service burst or message-

TABLE XVIII. Interleaver sequence--block 1.

INPUT ORDER	OUTPUT ORDER	INPUT ORDER	OUTPUT ORDER	INPUT ORDER	OUTPUT ORDER	INPUT ORDER	OUTPUT ORDER
0	19	28	22	56	4	84	69
1	61	29	85	57	60	85	84
2	86	30	32	58	108	86	13
3	49	31	106	59	68	87	43
4	94	32	73	60	44	88	93
5	25	33	23	61	52	89	103
6	87	34	3	62	2	90	77
7	34	35	88	63	110	91	64
8	9	36	96	64	72	92	15
9	50	37	28	65	10	93	24
10	107	38	79	66	35	94	89
11	99	39	41	67	53	95	75
12	8	40	59	68	97	96	33
13	40	41	11	69	62	97	47
14	111	42	70	70	0	98	5
15	74	43	42	71	81	99	95
16	65	44	21	72	12	100	57
17	45	45	29	73	109	101	46
18	14	46	1	74	91	102	7
19	83	47	101	75	20	103	82
20	30	48	90	76	51	104	56
21	48	49	16	77	6	105	38
22	58	50	80	78	37	106	102
23	100	51	54	79	63	107	76
24	26	52	67	80	78	108	66
25	39	53	27	81	55	109	17
26	71	54	105	82	18	110	36
27	104	55	92	83	31	111	98

TABLE XIX. Interleaver sequence--block 2.

INPUT ORDER	OUTPUT ORDER	INPUT ORDER	OUTPUT ORDER	INPUT ORDER	OUTPUT ORDER	INPUT ORDER	OUTPUT ORDER
112	116	140	203	168	131	196	195
113	140	141	137	169	166	197	215
114	193	142	129	170	177	198	125
115	156	143	180	171	123	199	164
116	214	144	219	172	223	200	112
117	171	145	209	173	208	201	172
118	205	146	190	174	144	202	220
119	113	147	160	175	114	203	206
120	181	148	198	176	122	204	158
121	128	149	118	177	134	205	192
122	221	150	212	178	162	206	174
123	211	151	141	179	154	207	145
124	120	152	173	180	202	208	153
125	196	153	161	181	191	209	216
126	147	154	204	182	218	210	207
127	182	155	126	183	124	211	127
128	139	156	143	184	136	212	184
129	115	157	217	185	178	213	175
130	152	158	167	186	151	214	142
131	165	159	157	187	119	215	121
132	187	160	133	188	138	216	200
133	176	161	148	189	130	217	168
134	201	162	213	190	170	218	183
135	210	163	197	191	155	219	149
136	150	164	169	192	194	220	199
137	132	165	222	193	135	221	163
138	189	166	188	194	185	222	186
139	179	167	146	195	159	223	117

service packet contains an integer number of 112-bit interleaver blocks.

For the coding rates for which the number of bits out of the encoder are not sufficient to fill the last interleaver block, fill bits shall be added resulting in a full interleaver block having 112 over-the-air bits. The fill bits shall have the pattern 10011001. For example a 2400 bps circuit using FEC code rate 7/8 will have (21,504) / 7/8 = 24,576 bits resulting in (24,576 / 112 = 219.42857 interleaver blocks. For this case the 220th interleaver block of each burst will contain 48 coded bits followed by 64 fill bits having the pattern 10011001.

5.4.4 Modulation requirements

5.4.4.1 Modulation formats. The modulation for all transmissions shall be 50% SOQPSK. The ideal SOQPSK signal can be represented as

$$s(t) = A \sin[w_o t + \phi(t)]$$

$$= \frac{A}{\sqrt{2}}\, a_i(t) \cos\left(w_o t + \frac{\pi}{4}\right) + \frac{A}{\sqrt{2}}\, a_q\left(t - \frac{T}{2}\right) \sin\left(w_o t + \frac{\pi}{4}\right)$$

where

the steady-state values of $\Phi(t)$ = 0, $\pi/2$, π, and $3\pi/2$,

and where

$a_i(t)$	=	in-phase data modulation signal, with shaping, as shown by example on Figure 12
$a_q(t)$	=	quadrature data modulation signal, with shaping, as shown by example on Figure 12
T	=	symbol period (reciprocal of the modulation rate)

Below, in a through c, is an explanation of how this SOQPSK signal expression relates to the I and Q channels, I/O data rates, spectral shaping, and Figure 12:

a. By definition, the QPSK modulated radio frequency (rf) signal contains 2 data bits per symbol. Therefore, the modulation rate, in sps, is one-half the transmit data rate in bps. Transmit data bits consist of all user data, extra bits introduced by FEC coding, and all overhead introduced by the terminal, including Preamble field bits, SOM field bits, Burst-Type field bits, and other bits defined in this standard. The transmit data forms a sequence b_j, where the b_1 equals the first transmit bit, b_2 equals the second transmit bit, and so forth. The transmit data is divided into the two modulation bit sequences $a_i(t)$ and $a_q(t)$. The sequence $a_i(t)$ consists of the odd members of the sequence b_j (b_1, b_3, b_5,...) and the sequence $a_q(t)$ consists of the even members of the sequence b_j (b_2, b_4, b_6 ...) as shown on Figure 12. Data buffering is used to accommodate I/O data-rate and modulation-rate inequalities.

b. In the above equation, the representation of the signals are: +1 for $a_i(t)$ or $a_q(t)$ corresponds to a bit value of 1, and -1 corresponds to a bit value of 0. At the start of a transmission while the first bit on the I channel is being transmitted, a bit value of 1 is transmitted on the Q channel during the first quarter of a symbol period. At the end of any transmission while the last data bit is being transmitted on either the I or Q channel, during the last half-symbol period, the bit level most recently transmitted on the other channel continues to be transmitted with no change.

c. For 3.0 ksps the sinusoidal transitions on $a_i(t)$ and $a_q(t)$ result in a linear rate of change for phase and a constant-amplitude transmitted signal. Figure 12 shows the Q channel offset (staggered) relative to the I channel by one-half of a symbol. At a time 75 percent through a symbol period, on either the I or Q channel, prior to a change in the modulation data bit, the signal begins a sinusoidal transition toward the value corresponding to the next modulation data bit. The signal reaches the new value at a time 25 percent into the next symbol period.

5.4.4.2 Modulation rates. The modulation rates shall be 600, 800, 1200, 2400, and 3000 sps, as specified in Table III.

5.4.4.3 Adjacent channel emissions. In a nominal 5-kHz bandwidth whose center frequency is displaced by Δf from a terminal transmitter's carrier frequency, the effective isotropically radiated power (eirp) shall be as specified in Table XX.

5.4.4.4 Modulation performance. The terminal's modulated output, including additive noise, shall introduce no greater than a 0.2 dB degradation in a receiver's performance, if the receiver uses matched filter demodulation and expects the incoming signal to have 50 percent sinusoidally shaped modulation, as illustrated on Figure 12. Note that the shaping referred to as 50 percent sinusoidally shaped modulation spreads each phase transition over a total time interval of T/2, as shown on Figure 12.

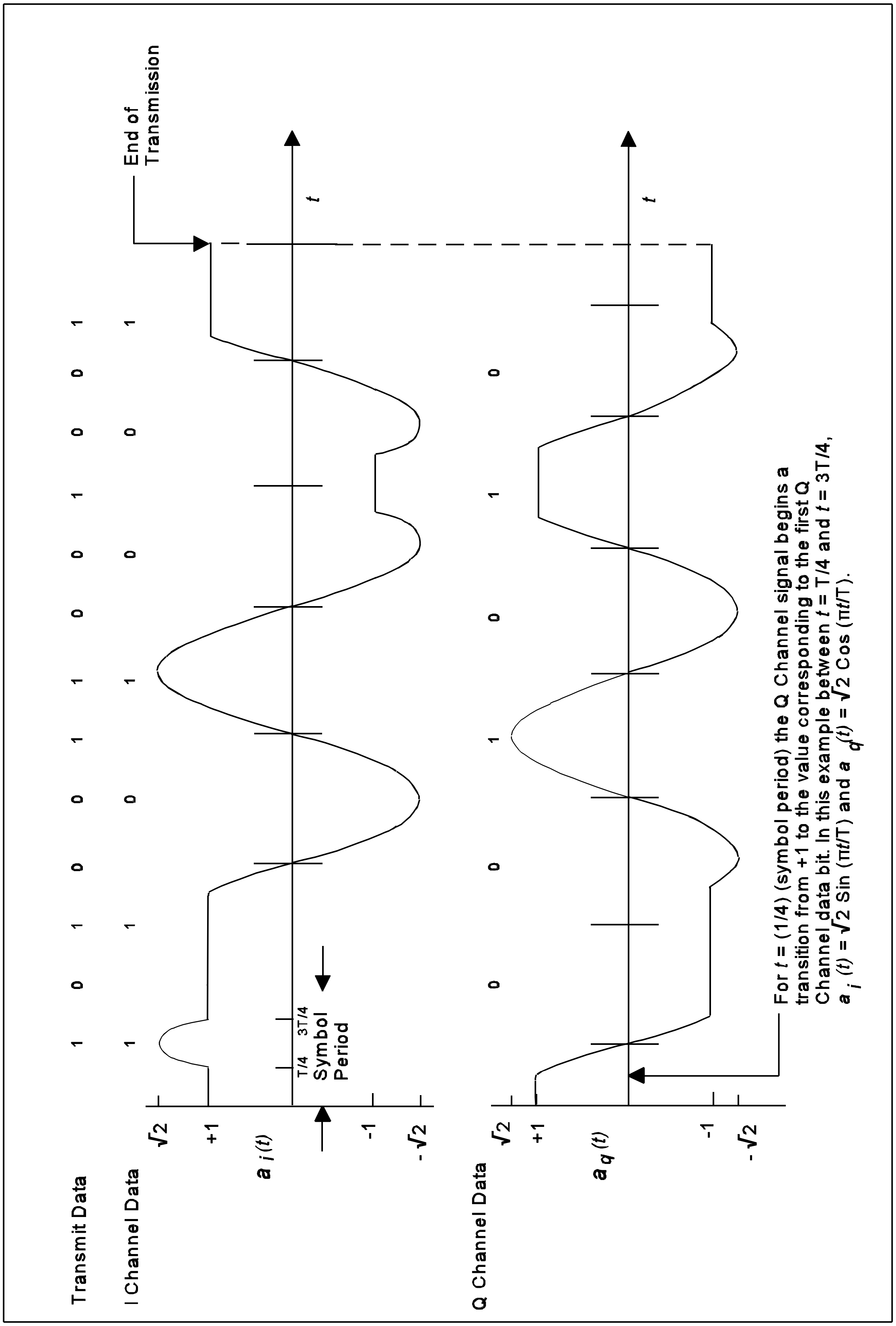


FIGURE 12. Example input to the modulator.

TABLE XX. Allowable adjacent channel emissions, narrowband.

Δf (kHz)	RELATIVE EIRP (dB) (CARRIER LEVEL < +18 dBW)	MAXIMUM EIRP (dBW) (CARRIER LEVEL $\geq$ +18 dBW)
	3.0 ksps SOQPSK	3.0 ksps SOQPSK
5	-14	+4
10	-34	-16
15	-38	-20
$\geq$20	-40	-22

5.5 Security characteristics

5.5.1 Orderwire encryption/decryption. All orderwires shall be encrypted for normal transmission; however, an orderwire encryption/decryption bypass shall be provided. Orderwire encryption/decryption shall be performed using the communications security (COMSEC)/TRANSEC Integrated Circuit (CTIC) or an alternate NSA-approved device that is cryptographically and functionally compatible with the CTIC implementing KGV-11, as specified in NSA No. 88-4 and NSA No. 87-01. Hardware implementation of the terminal shall include provisions for future implementation of over-the-air-rekeying (OTAR) for the orderwire. Input to the encryption/decryption process shall be a cryptographic key and an initialization vector called the Time Slot Number (TSN).

5.5.1.1 COMSEC Orderwire key selection. The terminal shall have storage for up to eight COMSEC keys. Each COMSEC key shall be loaded into a specific location in the terminal's key storage memory, numbered from 0 to 7. The network administrator will determine how many COMSEC keys will be used in the local network and into which storage location each key will be loaded. A COMSEC key will be used for a cryptographic period limited by the 20-bit frame number and by the network administrator. Upon expiration of the cryptographic period, the PCC will direct a rollover to another COMSEC key, identified by storage location number. The rollover sequence will begin with the transmission of the FOW:Next Key Indicator system message in four successive frames. This will be followed by the FOW:Time Slot Change Countdown system message, announcing the rollover in the next four frames. The new COMSEC key shall take effect in the frame after the fourth FOW:Time Slot Change Countdown message. When a terminal enters the network, it shall try all loaded COMSEC keys until it correctly decrypts the FOW (determined by a correct CRC). If the terminal enters the network during the Time Slot Countdown, it will have missed the Next Key Indicator and shall determine the next key using the trial process for all stored COMSEC keys (until obtaining the correct CRC).

5.5.1.2 Time Slot Number definitions. A 39-bit TSN shall be used as the cryptographic initialization vector for the CTIC. This TSN shall have four fields, as shown on Figure 13 and described below.

BITS

39 33	32 13	12 3	2 1
NET NUMBER	**FRAME NUMBER**	**FRAME OFFSET**	**OPERATOR ALLOWANCE**

FIGURE 13. Time Slot Number (TSN) format.

a. Net Number field. This 7-bit field contains the number of the DAMA network within which the terminal communicates. The Net Number field shall be 127 (1111111).

b. Frame Number field. This field contains the most recent 20-bit frame number transmitted by the PCC in the FOW.

c. Frame Offset field. This 10-bit field indicates the number of the first building block in the time slot in which the message is scheduled. It shall be coded from 0 through 1023 for the first through 1,024th building block in the frame. The Frame Offset field shall be zero for the FOW.

d. Operation Allowance field. This is a 2-bit field that shall start at a value of zero for all encryptions and decryptions. This field allows for various hardware implementations of the security requirements and is required for the CTIC implementation. The TSN for encryption of the orderwire shall be generated using the Frame Number and Frame Offset fields of the time slot within which the orderwire is scheduled. The TSN for decryption of the orderwires shall be generated using the Frame Number and Frame Offset fields of the time slot within which the orderwire was scheduled.

5.5.1.3 Encryption of the FOW. Encryption of the FOW will result in an output identical to that obtained from the following sequence:

a. Build the FOW using the PCC Address, Length of Next FOW, Contention Ranging Slots, System Message, Length of This FOW, and Directed Messages fields.

b. Generate the CRC and add it to the end of the FOW built in a.

c. Initialize the CTIC to operate in Mode B Encrypt Common Initialization, using the TSN defined in 5.5.1.2.

d. Encrypt the FOW beginning with the MSB of the PCC address and ending with the LSB of the CRC.

e. Add the Frame Number field (20 bits) to the beginning of the encrypted FOW.

f. Add the Flush field (6 bits) to the end of the FOW.

g. Error-correction-encode the resulting FOW.

h. Add the 600-sps Preamble, Start-of-Message, and Burst Type fields to the beginning of the FOW. The FOW is now complete and is ready for transmission. See Figure 2.

5.5.1.4 Decryption of the FOW. Decryption of the FOW shall result in an output identical to that obtained from the following sequence:

a. The 600-sps Preamble, Start-of-Message, and Burst Type fields are used for acquisition and are not used for further processing.

b. Error-correction-decode the remaining FOW data.

c. Build the TSN for CTIC initialization using the Frame Number field.

d. Initialize the CTIC to operate in Mode B Decrypt Common Synchronization, using the TSN as defined in 5.5.1.2.

e. Decrypt the FOW beginning with the MSB of the PCC address and ending with the LSB of the CRC.

f. Compute CRC on the decrypted data and compare it with the CRC field value (see 5.4.3.1).

The FOW now consists of the PCC Address, Length of Next FOW, Contention Ranging Slots, System Message, Length of This FOW, and Directed Message fields.

5.5.1.5 Encryption of the ROW. Encryption of the ROW shall result in an output identical to that obtained from the following processing sequence:

a. Build the ROW using the Node Address field and ROW message. For a ranging ROW there is no ROW message.

b. Generate the CRC and add to the end ROW built in a, above.

c. Initialize the CTIC to operate in Mode B Encrypt Common Initialization. The TSN shall be generated as defined in 5.5.1.2 using the same frame number transmitted by the PCC in the FOW of that frame.

d. Encrypt the ROW beginning with the MSB of the Node Address field and ending with the LSB of the CRC.

e. Add the Flush field (6 bits) to the end of the ROW.

f. Error-correction-encode the resulting ROW (see 5.4.3.2).

g. Add the Preamble, Start-of-Message, and Burst Type fields to the beginning of the ROW. The ROW is now complete and is ready for transmission. See Figures 3 and 4.

5.5.1.6 Decryption of the ROW. The decryption of the ROW will result in an output identical to that obtained from the following sequence:

a. Delete the Preamble, Start-of-Message, and Burst Type fields as they are not used for further processing.

b. Error-correction-decode the remaining ROW data.

c. Initialize the CTIC to operate in Mode B Decrypt Common Synchronization, using the TSN as defined in 5.5.1.2.

d. Decrypt the ROW beginning with the MSB of the Node Address field and ending with the LSB of the CRC.

e. Generate a CRC on the decrypted data and compare it with the CRC field value (see 5.4.3.1).

The ROW now consists of Node Address and ROW Message fields. For a ranging ROW there is no ROW Message field.

5.5.1.7 Zeroize. When a terminal receives a FOW:Zeroize message (FOW 31), it shall compare the Address 1 and Address 2 fields. If the values of these two fields are identical and match the terminal's node address, the terminal shall zeroize the eight locations in its key storage memory. If the two fields are not identical, the terminal shall ignore the FOW.

5.5.2 User data encryption/decryption. The protection of user data during transmission is referred to herein as COMSEC. Classified information will be encrypted for transmission. Unclassified information may be transmitted as cipher text or plain text. The terminal originating a service request shall indicate whether or not the user data is to be encrypted. The PCC will include the requestor-specified encryption indication in service assignments. Terminals shall transmit user data in plain text only if authorized by the terminal operator.

5.5.2.1 Voice security. Secure voice at 2400 bps shall be interoperable with the digitization and encryption techniques used in the Advanced Narrowband Digital Voice Terminal (ANDVT), application 3 (see 6.7.1 for current version of MIL-C-28883, and see 6.7.2 for discussion of other possible voice digitization techniques).

5.5.2.2 Data security. Data encryption shall be interoperable with KYV-5 and KG-84A/C encryption devices as specified in NSA No. 82-28. Terminals that embed COMSEC devices shall support all data rates specified in this standard for communications over the DAMA channel.

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6. NOTES

(This section contains information of a general or explanatory nature which may be helpful, but it is not mandatory.)

6.1 Communications scenarios. The following communications scenarios can take place using the equipment in global locations shown on Figure 14, with all terminals and channel controllers (CC) logged in and connected:

- Message service from T1 to T2
- Message service from T1 to Subnet T2 and T6
- Half-duplex circuit service from T1 to T2
- Half-duplex multiple-hop circuit service from T1 to T3

The scenarios and equipment locations were chosen to demonstrate the interaction of the largest number of FOWs and ROWs possible. If PCC2 and ACC2 were to interchange locations, the number of FOWs and ROWs would change. If multiple-hop communications were required to pass through more than just two satellites, then the quantity of FOWs and ROWs would go up proportionally. The interchange of orderwire messages to request and set up various services and transmit user information is described in 6.1.1 through 6.1.4.

6.1.1 Message service from T1 to T2

a. T1-PCC1 ROW:Message Setup (contention)

b. PCC1-T1 FOW:Message Setup Response

c. PCC1-T1&T2 FOW:Message Assignment (assigns communications time slots)

d. T1-T2 message packets transmitted

(c. & d. repeated as often as necessary)

e. PCC1-T2 FOW:Acknowledge Blocks (assigns ROW time slot)

f. T2-PCC1 ROW:Block Acknowledgment (not all packets acknowledged)

g. PCC1-T1&T2 FOW:Message Assignment (assigns communications time slots)

h. T1-T2 data blocks not acknowledged are transmitted

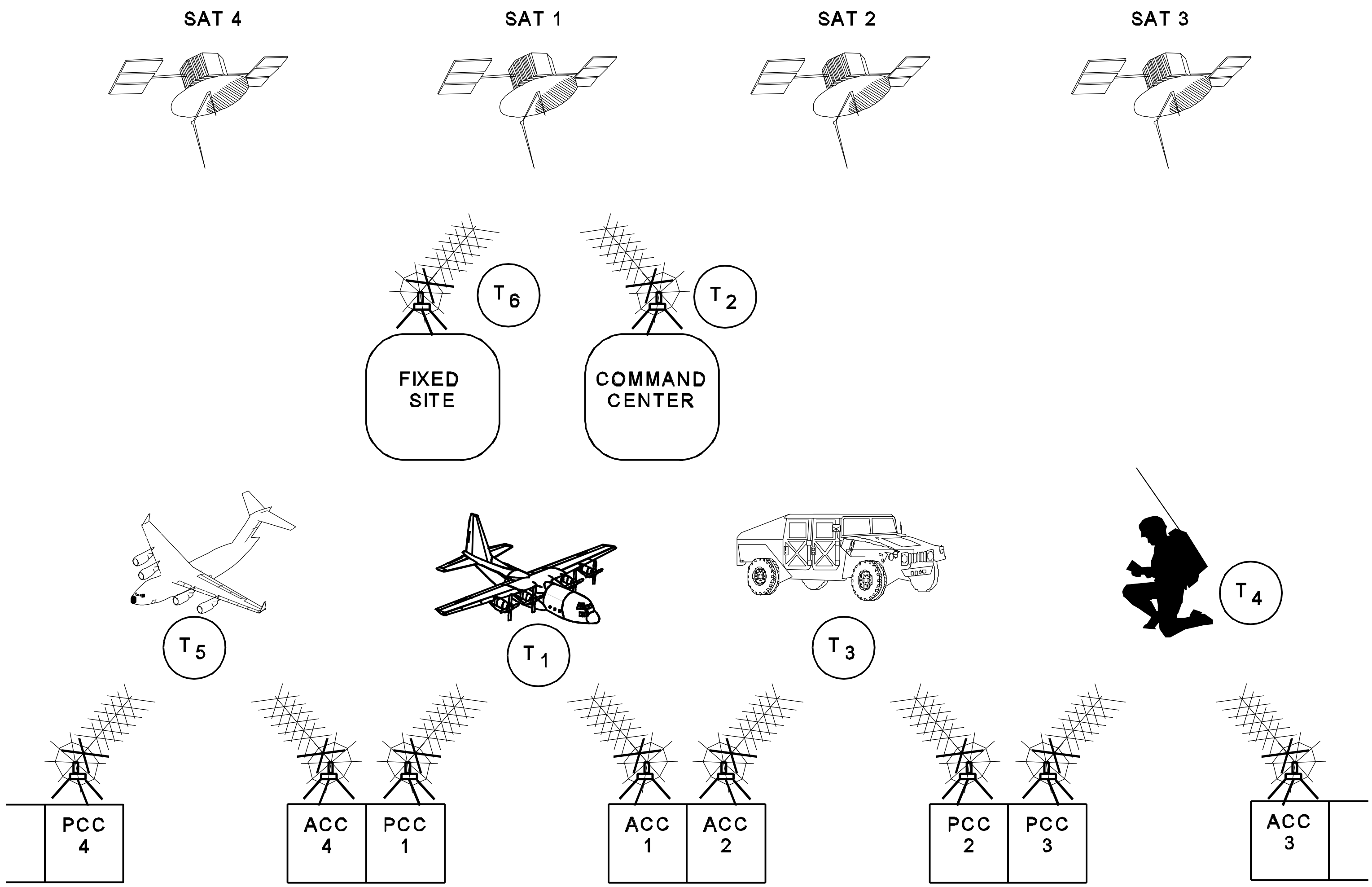

FIGURE 14. Communications scenarios and equipment locations.

i.	PCC1-T2	FOW:Acknowledge Blocks (assigns ROW time slot)
j.	T2-PCC1	ROW:Block Acknowledgment (all packets acknowledged)
k.	PCC1-T1	FOW:Message Acknowledgment (Acknowledgment Type field set to binary 0).
l.	PCC1-T2	FOW:Acknowledge Message (assigns ROW time slot)
m.	T2-PCC1	ROW:Message Acknowledgment
n.	PCC1-T1	FOW:Message Acknowledgment (Acknowledgment Type field set to binary 1).

6.1.2 Message service from T1 to subnets T2 & T6

a.	T1-PCC1	ROW:Message Setup (contention)
b.	PCC1-T1	FOW:Message Setup Response
c.	PCC1-T1	FOW:Message Assignment (assigns Subnet communications time slots)
d.	T1-Subnet	data blocks transmitted

(c. & d. repeated as often as necessary)

e.	PCC1-T1 & Subnet	FOW:Message Teardown

6.1.3 Half-duplex circuit service from T1 to T2

a.	T1-PCC1	ROW:Circuit Setup (contention)
b.	PCC1-T1	FOW:Circuit Setup Response
c.	PCC1-T1&T2	FOW:Circuit Assignment (assigns communications time slots)
d.	T1-T2 or T2-T1	communications bursts transmitted

(c. & d. repeated as often as necessary)

e.	T1-PCC1 or T2-PCC1	Start to transmit End-of-Service burst type

f.	PCC1-T1&T2	FOW:Circuit Teardown

If the preceding FOW is not received, then the following steps are taken:

g.	T1-PCC1 or T2-PCC1	ROW:Circuit Teardown (contention)
h.	PCC1-T1&T2	FOW:Circuit Teardown

For a full-duplex communications service, two communications time slots are assigned using separate FOW directed messages in step c. Then in step d above, T1-T2 or T2-T1 becomes T1-T2 and T2-T1.

6.1.4 Half-duplex multiple-hop circuit service from T1 to T3

a.	T1-PCC1	ROW:Circuit Setup (contention)
b.	PCC1-T1	FOW:Circuit Setup Response
c.	PCC1-ACC1	FOW:Relay Ringup (assigns ROW time slot)
d.	ACC1-PCC1	ROW:Relay Ringup Response
e.	ACC2-PCC2	ROW:Relay Ringup (contention)
f.	PCC2-ACC2	FOW:Relay Ringup Response
g.	PCC2-ACC2	FOW:Relay Select (assigns ROW time slot)
h.	ACC2-PCC2	ROW:Relay Select Response (contention)
i.	ACC1-PCC1	ROW :Relay Select (contention)
j.	PCC1-ACC1	FOW:Relay Select Response
k.	PCC2-ACC2&T3	FOW:Multiple-Hop Circuit Assignment
l.	ACC1-PCC1	ROW:Multiple-Hop Begin Assignments (contention)
m.	PCC1-ACC1	FOW:Multiple-Hop Begin Assignment
n.	PCC1-T1 & ACC1	FOW:Multiple-Hop Circuit Assignments
o.	T1-ACC1 and ACC2-T3, or T3-ACC2 and ACC1-T1	communications bursts transmitted

(o is repeated as often as necessary)

PCC2 preempts communications

p.	ACC1-PCC1	ROW:Multiple-Hop Circuit Preemption (contention)
q.	PCC1-ACC1	FOW:Multiple-Hop Circuit Preemption Response

PCC1 preempts communication

PCC2 resumes communications by

r.	PCC2-T3&ACC2	FOW:Multiple-Hop Circuit Assignment
s.	ACC1-PCC1	ROW:Multiple-Hop Circuit Resumption (contention)

(s is repeated as often as necessary)

t.	PCC1-T1&ACC1	FOW:Multiple-Hop Circuit Assignment
u.	T1-ACC1 and ACC2-T3, or T3-ACC2 and ACC1-T1	communications bursts transmitted

(u is repeated as often necessary)

v.	T1-ACC1	End-of-Service burst type starts to be transmitted in band
w.	PCC1-T1&ACC1	FOW:Multiple-Hop Circuit Teardown
x.	ACC1-PCC1	ROW:Multiple-Hop Circuit Teardown response
y.	ACC2-PCC2	ROW:Multiple-Hop Circuit Teardown (contention)
z.	PCC2-T3&ACC2	FOW:Multiple-Hop Circuit Teardown
aa.	ACC2-PCC2	ROW: Multiple-Hop Circuit Teardown Response (assigned)

If full-duplex communications is supportable by each terminal, then two communications time slots are assigned (two different FOWs) in steps k, n, r, and t, above.

6.2 Communications time-slot assignment example. Terminals request assignments to the communications portion of the frame by sending ROW messages to the PCC. The PCC assigns communications time slots to terminals, using FOW messages. The following example demonstrates this assignment process and shows how FOW messages are used to assign communications time slots.

EXAMPLE: Assume that four terminals (Terminal A, Terminal B, Terminal C, and Terminal D) have gained access to the network. The following services are required:

Terminal A: A half-duplex, data circuit service with an I/O data rate of 300 bps

Terminal B: A message service

Terminal C: A message service

Terminal D: A message service

Each terminal sends a ROW message to the PCC requesting these services. Terminal A sends a ROW:Circuit Setup message while Terminals B, C, and D send ROW:Message Setup messages. Assume that the PCC receives each request without difficulty and processes each request. It responds with the FOW communications assignment messages shown on Figure 15.

STEP 1: Determine the communications time-slot length that the PCC has assigned to each service.

The four FOW directed messages each assign a separate time slot in the communications portion of the frame. Each FOW must be parsed by each of the terminals to determine the total number of building blocks allocated for the communications portion of the frame. The number of building blocks assigned to each communications time slot can be determined using the information provided in the FOW message fields and Tables IV and V. In FOW #1, the message fields indicate that Terminal B will transmit 3 coded data blocks of information at a modulation rate of 600 sps. Referring to Table V, the time-slot size required to handle this transmission is 169 building blocks. In FOW #2, the message fields indicate that Terminal A's service is a half-duplex data circuit with an I/O rate of 300 bps, and that the transmission will be coded and modulated at a 1200-sps rate. Referring to Table IV, the time-slot length for this transmission will be 278 building blocks. In FOW #3, the message fields indicate that Terminal C will transmit 9 coded data blocks of information at a modulation rate of 2400 bps. Referring to Table V, the time-slot size required to handle this transmission is 111 building blocks. In FOW #4, the message fields indicate that Terminal D will transmit two uncoded data blocks of information at a modulation

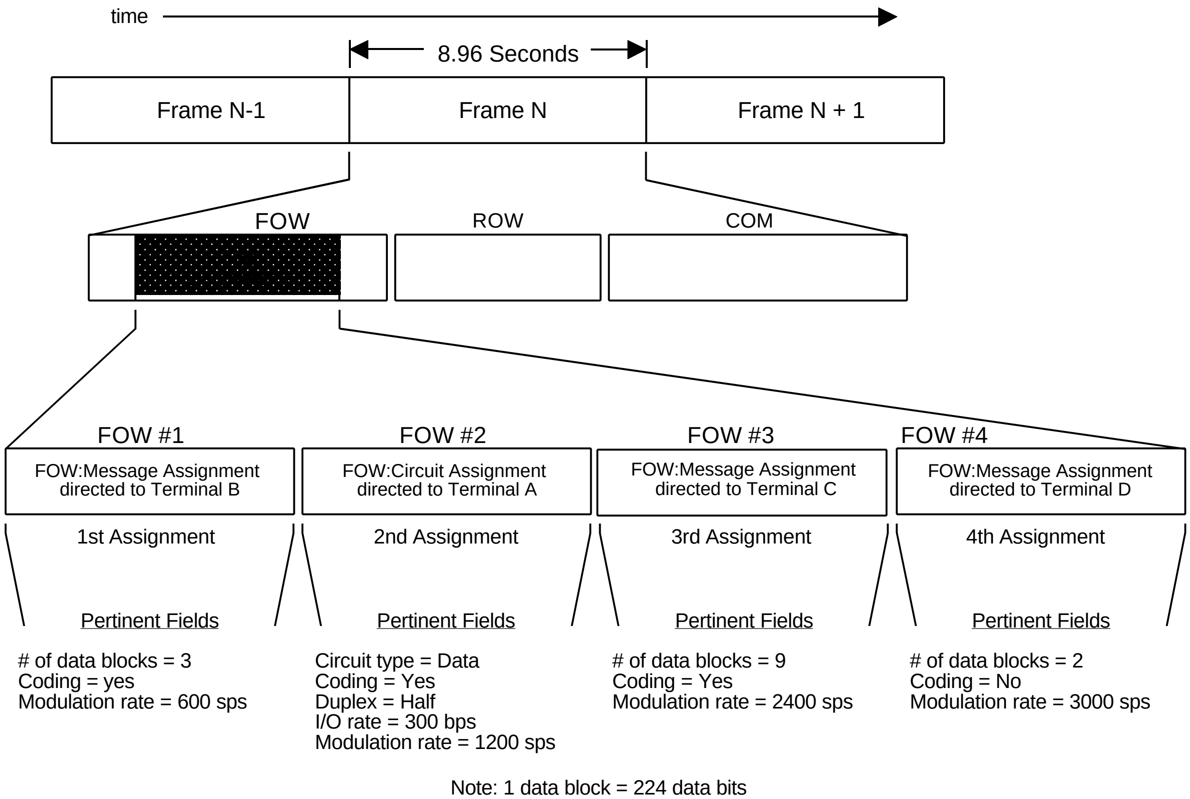

FIGURE 15. FOW communications assignment messages.

rate of 3000 sps. Referring to Table V, the time-slot size required to handle this transmission is 21 building blocks.

STEP 2: Determine the starting location for each communications time slot.

The determination of the starting location for a communications time slot is based on the ordering of assignments in the FOW. Time slots are assigned from the latest (last) time slot to the earliest (first) time slot. Thus, the service receiving the first assignment in the FOW will transmit during the last time slot in the communications portion of the next frame, the second assignment in the FOW will transmit in the second-to-last time slot in the next frame, and so forth. Therefore, the starting location for each communications time slot in this example is as shown on Figure 16.

6.3 ROW time-slot assignment example. ROW time slots are assigned by the FOW directed messages as are the assignments of communications resources. The assigned ROW time slots follow the last contention ranging time slot in the ROW portion of the frame and therefore begin with the next ROW time slot in the frame (see Figure 4). The determination of the actual ROW time-slot assignment is based on the ordering of assignments in the FOW.

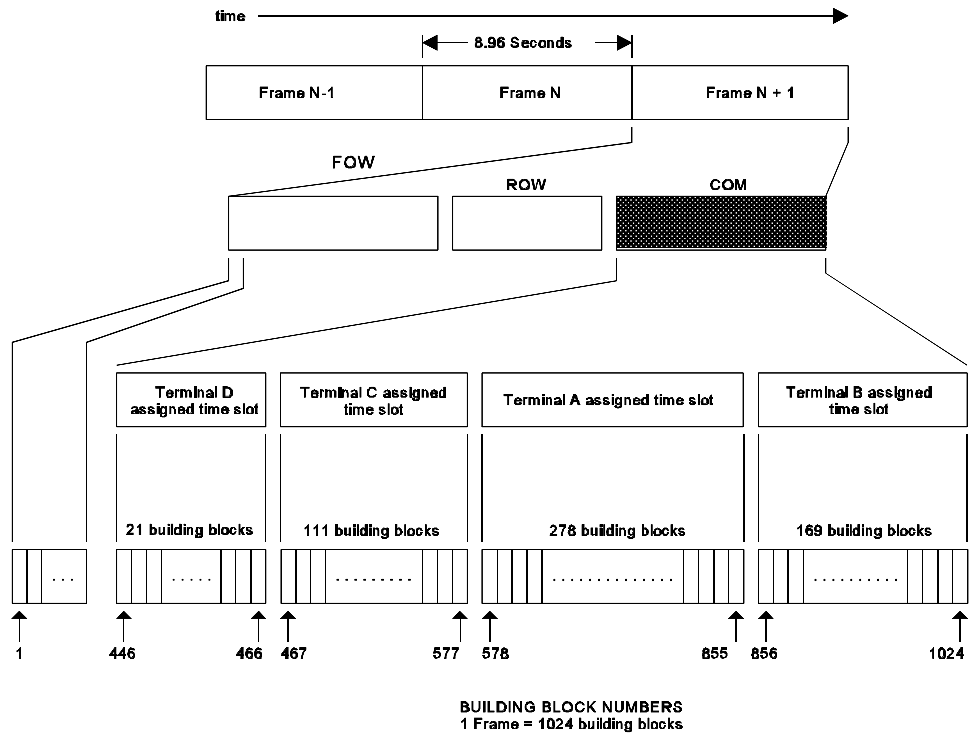

FIGURE 16. Starting location for communications time slot.

ROW time slots are assigned starting from the first time slot following the variable number of contention-ranging time slots. The following example demonstrates this assignment process and shows how FOW messages are used to assign ROW time slots.

EXAMPLE: Assume that the same four terminals as in section 6.2 (Terminal A, Terminal B, Terminal C, and Terminal D) are to be assigned individual ROW time slots. The FOW messages are transmitted by the PCC, as shown on Figure 17. The number of contention-ranging time slots are indicated in the FOW of the previous frame. In this example, assume that the number of contention-ranging time slots is equal to one.

The Length of Next FOW field in our example is 134 building blocks. Assigned ROW time slots follow the contention ranging time slot (which are 32 building blocks long). Therefore, the assigned-ROW time slots begin at building block 167 (135 + 32). Terminal D receives the first ROW assignment and transmits a ROW:Message Acknowledgment message at building block 167 of the next frame in response to FOW #10. Terminal B receives the second ROW assignment and transmits a ROW:Status Report message starting at building block 184 (167 + 17) of the next frame in response to FOW #11. Terminal C receives the third ROW assignment and will range starting at building block 201 (184 + 17) in response to FOW #12. Ranging time slots are 32 building blocks long. Terminal A receives the fourth ROW assignment

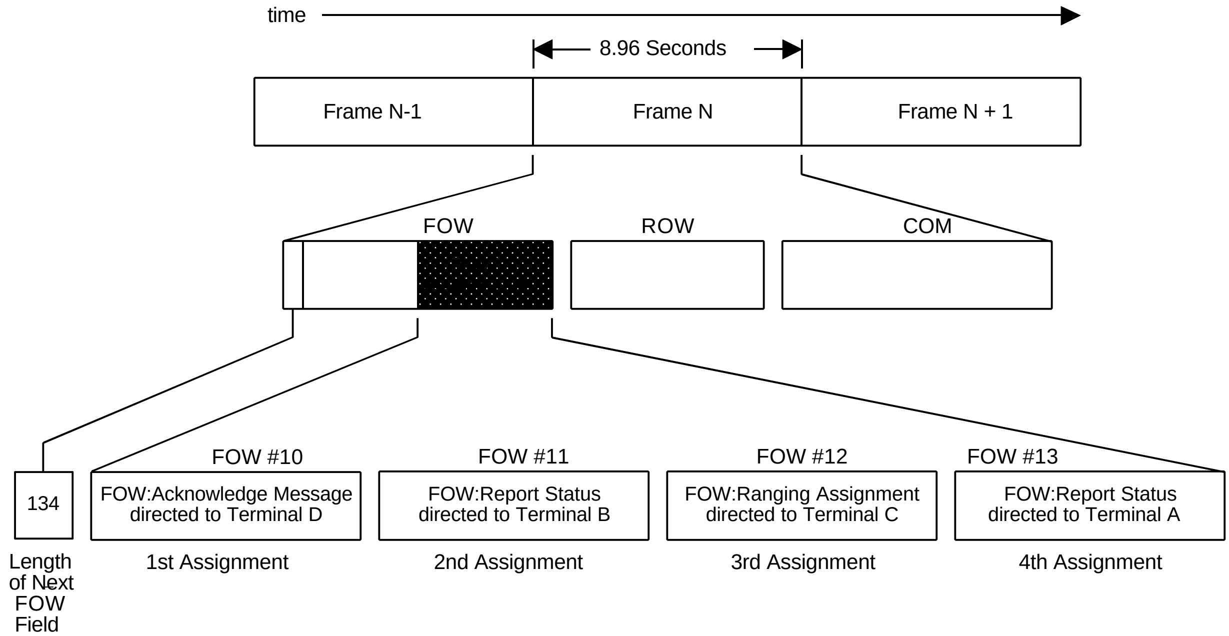

FIGURE 17. FOW messages transmitted by the PCC.

transmits a ROW:Status Report message starting at building block 233 (201 + 32) in response to the FOW:Report Status message. This is summarized on Figure 18.

6.4 Contention ROW segment size determination example. Using the frame defined in 6.2 and 6.3, the number of contention-ROW time slots available can be determined by dividing the number of building blocks in the contention portion of the ROW by the number of building blocks in a contention ROW (which is 17). By knowing the number of building blocks in the FOW, contention-ranging time slot, assigned-ROW time slots, and communications time slots, the number of contention-ROW time slots can be determined. Figure 19 illustrates the number of contention-ROW time slots available in the example. As illustrated, the contention-ROW time slots begin at building block number 250. Eleven contention-ROW time slots are available, each starting at 17 building block increments (for example: 250, 267, 284, 301...). Building Blocks 437 to 445 are not assigned any communications time slot and are not available for contention messages in this example.

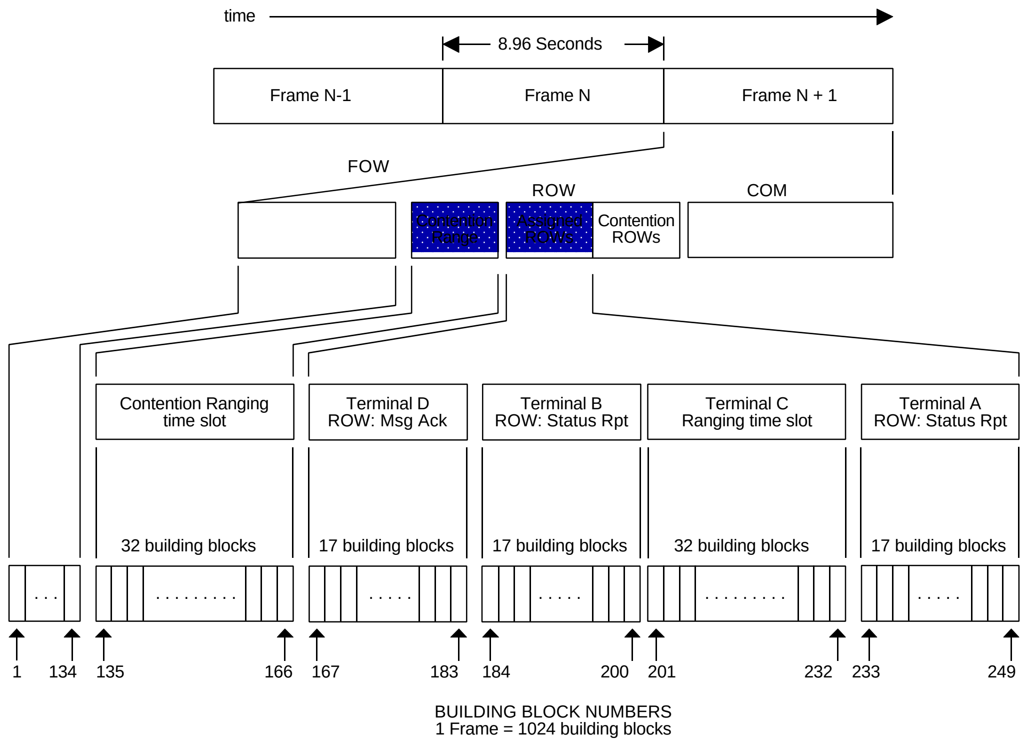

FIGURE 18. ROW time slot assignments.

6.5 CRC calculation example. The CRC specified within this standard is similar to, but not compatible with, the ITU-T CRC computation model. This standard requires data to be output MSB first, which is equivalent to data being output most significant byte first, with each byte being output most significant bit first. The ITU-T CRC computation model is based on data being output most significant byte first, with each byte being output least significant bit first. This results in a CRC different from that which is obtained using the scheme defined in this standard.

For conciseness, a 12-bit data string defined by the equation

$$D(x) = x^{11} + x^9 + x^7 + x^5 + x^3 + x$$

is chosen, and the 8-bit CRC is calculated. Using a simplified notation in which polynomials are represented by their ordered coefficients, the binary data stream on which the CRC is to be calculated is then 101010101010, where the leftmost bit is most significant (the MSB) and is to be transmitted first. The CRC generating polynomial is:

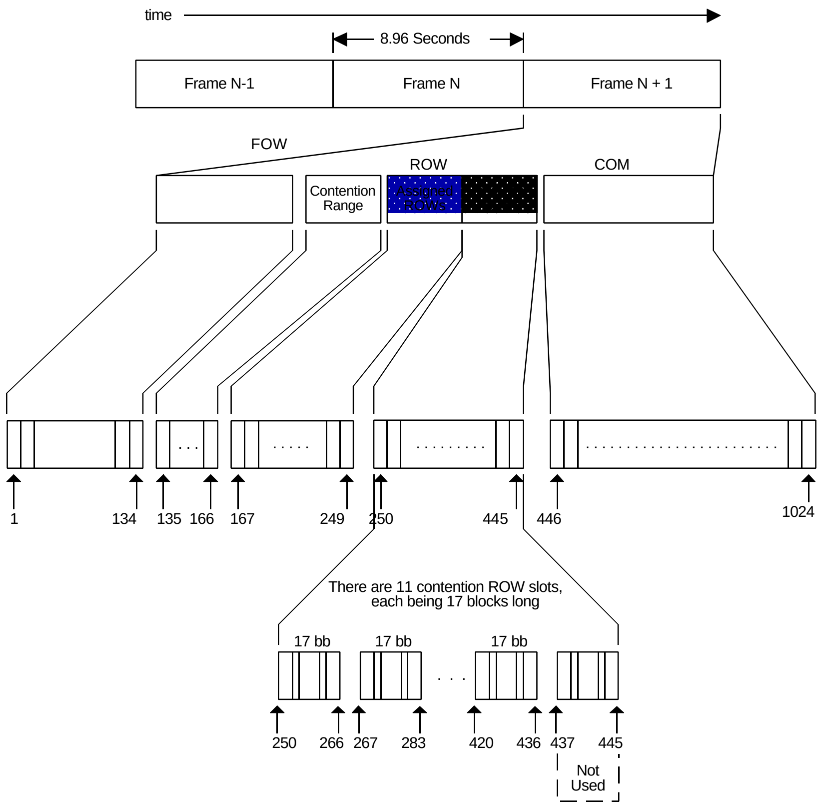

FIGURE 19. Contention ROW segment size determination.

$$G(x) = x^8 + x^7 + x^6 + x^3 + 1$$

and its binary data stream is:

111001001

where the leftmost bit is the most significant bit (MSB).

After zero fill of *D(x)* to a byte boundary followed by multiplication by X^8, *D(x)* becomes:

101010101010000000000000.

Division of *D(x)* by *G(x)* then is as follows:

```
                 1110011100100101
          _________________________
111001001)101010101010000000000000
          111001001
           100111000
           111001001
            111100011
            111001001
```

```
101010000
111001001
 100110010
 111001001
  111110110
  111001001
     111111000
     111001001
        110001000
        111001001
          100000100
          111001001
           11001101 <- remainder = CRC
```

The remainder of the division is the CRC, which is appended to the data stream, *D(x)*. Thus, the transmitted data stream is:

$$\begin{array}{cc} \underline{101010101010} & \underline{11001101} \\ a_{11} \qquad\qquad a_0 & \text{CRC} \end{array}$$

where the leftmost bit (a_{11}) is transmitted first.

6.6 Tailoring guidance. To ensure proper application of this standard, invitations for bids, requests for proposals, and contractual statements of work should tailor the requirements in sections 4 or 5 of this standard to exclude any unnecessary requirements. For example, if the statement of work requires a revision to a standard, then all the paragraphs related to handbooks, bulletins, and notices should be excluded.

6.7 Voice capability.

6.7.1 MIL-C-28883 baseline. At the time of publication of this standard the version of MIL-C-28883 available was MIL-C-28883A with change 2 and engineering change proposal (ECP) up through 060. Future use of this standard for system development should refer to latest version of this specification.

6.7.2 Mixed Excitation Linear Prediction (MELP). There are efforts underway to improve the quality of voice communications employing MELP techniques. MELP was developed by Texas Instruments under contract to NSA. Interim test results show that performance on a 2400 bps channel employing MELP is equivalent to or better than that on a 4800 bps channel employing CELP techniques. A federal standard is in the process of being developed. Pending completion of the federal standard, information on MELP is documented in NSA Report R22-03-96, "Analog to Digital Conversion of Voice by 2400 bps Mixed Excitation Linear Prediction", with NSA library number S243,638.

The NSA report contains the draft version of the federal standard. A DoD Digital Voice Processing Consortium is looking the implementing MELP into communications equipment. Assuming success in completing the federal standard, this voice digitization technique will have application for those terminals operating over UHF SATCOM.

6.8 Key-word listing. The following key words apply:

- fleet satellite communications system (FSCS)
- satellite communications (SATCOM)
- time-division multiple access (TDMA)
- 5-kHz UHF SATCOM channels

6.9 Identification of changes. Marginal notations are not used in this revision to identify changes with respect to the previous issue, due to the extent of the changes. Table XXI lists the major changes made and the paragraphs affected by the changes.

TABLE XXI. Major changes made to standard.

CHANGE	PARAGRAPH/FIGURE/TABLE AFFECTED
Format/editorial changes to comply with MIL-STD-962C.	Multiple
Globally changed use of the word *shall* to apply only to a testable terminal requirement.	Multiple
Added multiple-hop message service (packetized data delivery)	Tables I, II, X, XI, XII; 5.4.2.3; and Tables XVI, CXII, C-XV, and C-XVI
Added full-duplex voice capability.	Tables IV and C-V
Added requirement for starting transmission for voice service in middle of assigned time slot using subframing.	Table X, 5.1.3.1 d, 5.4.2.1.7.2, 5.4.2.2.4.2, and Tables B-IV, B-XIV, B-XXXIII and B-XXXIV
Added requirement that terminal may retain service requests when switching to a DASA channel and that PCC would not increment queue service timers for service requests.	5.4.2.4.2.2
Added capability for terminal transmission of status reports in contention time slot with restrictions.	5.4.2.5.5

TABLE XXI. Major changes made to standard. (concluded)

CHANGE	PARAGRAPH/FIGURE/TABLE AFFECTED
Added requirement for puncture codes to derive rate 3/4 and 7/8 FEC coding.	5.4.3.2.1
Added requirement for zeroizing COMSEC keys via orderwire command.	5.5.1.7, Table B-XXXIII
Modified Modulation field of FOWs 3, 9, and 13 to add capability to designate multiple coding rates.	Tables B-IV, B-X, and B-XIV
Added MIL-STD-188-182A as option for the Terminal Standard Version field.	Tables B-VII, B-XXa, C-III, C-IV, and C-VII
Added capability for terminal to advise what version of MIL-STD-188-183 the terminal complies with (added 25-kHz Standard Version field).	Table C-VII.
Modified I/O Data Rate field of ROWs 2, 3, and 6 to clarify terminal capability when switching to a DASA channel.	Tables C-III, C-IV, and C-VII
Added capability for terminal to decide whether to switch to a DASA channel upon receipt of command. Added Virtual Port and Precedence fields and modified Channel Duration field of FOW:Terminal Channel Reassignment message.	Table B-XXX.
Changed DASA channel data rate capability from 6000 bps to 6400 bps.	Tables B-XXX, C-III, C-IV, C-VII, and C-XXV.
Added second FOW:Terminal Channel Assignment message (FOW 32) applicable to MIL-STD-188-182A compliant terminals. FOW 29 noted as needed only for terminal use in determining FOW length.	
Changed name of FOW:Terminal Channel Return Response message to FOW:Contention Response.	Tables X and XI, 5.4.2.4.2.3, Table XXXI
Added field definition for terminal to advise PCC whether 25-kHz capable.	Tables C-VII and C-XXV

FOW SYSTEM MESSAGES

A.1 SCOPE

This appendix is a mandatory part of this standard. The information contained herein is intended for compliance. The System Message field within the forward orderwire (FOW) message, used to convey status and control parameters to terminals, is specified. The System Message field is discussed in 5.1.1 h. The bits within each field and the meaning assigned to each binary number is provided. Each terminal shall be capable of receiving and interpreting each of the message fields defined in this appendix.

TABLE A-I. FOW system message definitions.

FIELD	VALUE	NOTES
FOW:System Access Restriction	0-6	System access restriction 0 = Reserved 1 = Flash Override 2 = Flash 3 = Immediate 4 = Priority 5 = Routine 6 = Reserved
FOW:System Service Restriction On	7	Transmission of 2400-bps communications is inhibited.
FOW:System Service Restriction Off	8	Transmission of 2400-bps communications is allowed.
FOW:Single Access Channel Mode Countdown	9-12	Change in the local channel from multiple access to single access channel mode 12= Mode change occurring four frames from the present frame. 11= Mode change occurring three frames from the present frame. 10= Mode change occurring two frames from the present frame. 9= Mode change occurring in the next frame.
FOW:Channel Controller Isolated	13	Network is isolated (multiple hop not available).
FOW:Channel Controller Connected	14	Network is connected (multiple hop available).

TABLE A-I. FOW system message definitions (Concluded).

FIELD	VALUE	NOTES
FOW:Time Slot Change Countdown	15-18	18 = Crypto period rollover occurring four frames from present frame. 17 = Crypto period rollover occurring three frames from present frame. 16 = Crypto period rollover occurring two frames from present frame. 15 = Crypto period rollover occurring in next frame.
FOW:Manual Control Transition Countdown	19-22	PCC-to-ACC control transition 22 = Control transition occurring four frames from the present frame. 21 = Control transition occurring three frames from the present frame. 20 = Control transition occurring two frames from the present frame. 19 = Control transition occurring in the next frame.
FOW:ROW Backoff Number	23-27	Contention ROW retry backoff number 23 = 1 24 = 30 25 = 60 26 = 250 27 = 1000
FOW:Next Key Indicator	28-35	Key location to use during the next crypto period 28 = Next key location is location 0 29 = Next key location is location 1 . . . 35 = Next key location is location 7
Reserved	36-63	

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APPENDIX B

FOW DIRECTED MESSAGES

B.1 SCOPE

This Appendix is a mandatory part of this standard. The information contained herein is intended for compliance. The Directed Message field within the forward orderwire (FOW) message, used to assign network resources, request status, update guard lists, and other functions, is specified. The Directed Message field is discussed in 5.1.1 j. The bits within each field and the meaning assigned to each binary number transmitted in the Directed Message field is specified. Each terminal shall be capable of receiving and interpreting each of the messages defined in this appendix except for those defined in Tables B-3, B-13, B-15, B-17, B-18, B-21, and B-23 through B-26 which are used by controllers.

B.2 CONTENTS

The FOW messages included in this appendix are as follows:

TABLE B-I. FOW:Acknowledge Message message.

FIELD	BITS	VALUE	NOTES
Message Type	6	0	
Source Address	16		Source node address
Destination Address	16		Destination node address
Virtual Port Number	3	0-4 = Demand assigned 5-7 = Reserved	Unique request identifier
Total Size	41		

NOTE: This is sent by the PCC requesting the terminal to acknowledge the just received message. This also assigns ROW capacity for the response (ROW 8).

TABLE B-II. FOW:Acknowledge Blocks message.

FIELD	BITS	VALUE	NOTES
Message Type	6	1	
Source Address	16		Source node address
Destination Address	16		Destination node address
Virtual Port Number	3	0-4 = Demand assigned 5-7 = Reserved	Unique request identifier
Total Size	41		

NOTE: This is sent by the PCC requesting the terminal to acknowledge the just received message blocks. This also assigns ROW capacity for the response (ROW 18).

TABLE B-III. FOW:Alternate Channel Controller Designate Response message.

FIELD	BITS	VALUE	NOTES
Message Type	6	2	
Acknowledgment	1	0 = Accept control transition 1 = Reject control transition	
Status Report Polling Frequency	2	0 = 5 minutes 1 = 10 minutes 2 = 20 minutes 3 = 40 minutes	Control transition data base item
Queued Service Timeout	11	0-6 = Reserved 7-805 = Timeout value in frames 806-2047 = Reserved	Control transition data base item
Queued Multiple-Hop Service Timeout	11	0-6 = Reserved 7-1342 = Timeout value in frames 1343-2047 = Reserved	Control transition data base item
Unused Service Timeout	11	0-6 = Reserved 7-1342 = Timeout value in frames 1343-2047 = Reserved	Control transition data base item
Minimum Contention ROWs	5	0-20 = Minimum number of contention-ROW time slots per frame 21-31 = Reserved	Control transition data base item
Multiple-Hop Limit	2	0 = 1-hop limit (local service only) 1 = 2-hop limit 2 = 3-hop limit 3 = 4-hop limit	Control transition data base item
Total Size	49		

NOTE: This is sent by the PCC in response to a request (ROW 0) from the ACC to assume channel control.

TABLE B-IV. FOW:Circuit Assignment message.

FIELD	BITS	VALUE	NOTES
Message Type	6	3	
Source Address	16		Source node address
Destination Address	16		Destination node or subnet address
Virtual Port	3	0-4 = Demand assigned 5 = Preassigned 6,7 = Reserved	Unique request identifier
Circuit Type	1	0 = Data 1 = Voice	
Asynchronous Service Indicator	1	0 = Synchronous User I/O 1 = Asynchronous User I/O	
Precedence	3	0 = Preassigned 1 = Flash Override 2 = Flash 3 = Immediate 4 = Priority 5 = Routine 6,7 = Reserved	
Duplex	2	0 = Half-duplex 1 = Full-duplex, source-to-destination 2 = Full-duplex, destination-to-source 3 = Reserved	Defines communications capability(half- or full-duplex) and, in the case of full-duplex, the direction assignment for the time slot.

TABLE B-IV. FOW:Circuit Assignment message (Concluded).

FIELD	BITS	VALUE	NOTES
I/O Data Rate and Burst Format Type	4	0 = 75 bps 1 = 300 bps 2 = 600 bps 3 = 1200 bps 4 = 2400 bps, data/fixed voice 5 = 2400 bps, subframed voice 6-15 = Reserved	
Coding	1	0 = No error correction encoding 1 = Error correction encoded	
Modulation and Coding Rate	4	0 = 600 sps (See Note 2) 1 = 1200 sps (See Note 2) 2 = 2400 sps (See Note 2) 3 = 3000 sps (See Note 2) 4 = 600 sps, Rate 3/4 5 = 1200 sps, Rate 3/4 6 = 2400 sps, Rate 3/4 7 = 3000 sps, Rate 3/4 8-10 = Reserved 11 = 3000 sps, Rate 7/8 12-15 = Reserved	See Note 2
Encrypted Data	1	0 = Encrypted data 1 = Data not encrypted	
Total Size	58		

NOTES:

1. This is sent by the PCC in response to a request (ROW 4) from a network member to setup a circuit service. This FOW assigns communications time slot and other parameters of the communications.
2. For values 0, 1, 2, and 3 in the Modulation and Coding Rate field the value in the Coding field will indicate whether code rate 1 or 1/2 is employed. If Coding field has value 0, code rate 1 is used and if value 1, rate 1/2 is used. For values 4, 5, 7, and 10 in the Modulation and Coding Rate field the value in Coding field will be set to 1.

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TABLE B-V. FOW:Circuit Setup Response message.

FIELD	BITS	VALUE	NOTES
Message Type	6	4	
Source Address	16		Source node address
Destination Address	16		Destination node or subnet address
Virtual Port	3	0-4 = Demand assigned 5 = Preassigned 6,7 = Reserved	Unique request identifier
Request Status	4	0 = Queued, local 1 = Rejected, terminal access restriction violation 2 = Rejected, system access restriction violation 3 = Rejected, no capacity 4 = Rejected, destination not logged in 5 = Rejected, no multiple-hop resources available 6 = Queued, multiple hop 7 = Rejected, system service restriction violation 8 = Rejected, I/O data rate incompatibility 9 = Rejected, network isolated 10 = Queued, dedicated channel 11 = Rejected, channel not available 12 = Rejected, service not assignable 13 = Rejected, frequency switching incompatibility 14-15 = Reserved	
Total Size	45		

NOTE: This is sent by the PCC in response to a request (ROW 4) from a network member to setup a circuit service. This FOW announces if the circuit service is queued or why the service request is rejected.

TABLE B-VI. FOW:Circuit Teardown message.

FIELD	BITS	VALUE	NOTES
Message Type	6	5	
Source Address	16		Source node address
Destination Address	16		Destination node or subnet address
Virtual Port	3	0-4 = Demand assigned 5 = Preassigned 6,7 = Reserved	Unique request identifier
Reason	4	0 = Operator requested teardown 1 = Participant not logged in 2 = Preemption timeout 3 = Queued service timeout 4 = Multiple-hop circuit setup failed 5 = Precedence override 6 = Reserved 7 = End-to-end bit timing loss 8 = I/O data rate incompatible 9 = Unknown service 10 = Reserved 11 = CS operator requested teardown 12,13 = Reserved 14 = Unused circuit timeout 15 = Reserved	
Total Size	45		

NOTE: This is sent by the PCC to teardown a circuit service. This FOW announces why the circuit service is being torn down. It may also be sent in response to ROW:Circuit Teardown (ROW 5).

TABLE B-VII. FOW:Login Response message.

FIELD	BITS	VALUE	NOTES
Message Type	6	6	
Source Address	16		Source node address
Response	3	0 = Accepted 1 = Rejected, no capacity (login count limit exceeded) 2 = Rejected, not authorized 3 = Rejected, ACC already logged in 4 = Rejected, terminal address above demarcation 5 = Rejected, invalid login address 6,7 = Reserved	
Precedence	3	0 = Reserved 1 = Flash Override 2 = Flash 3 = Immediate 4 = Priority 5 = Routine 6,7 = Reserved	Terminal or CC service restriction (maximum allowed precedence level) for demand-assigned service requests
Address Demarcation	16		Dividing line between node and subnet address
Terminal Standard Version	4	0 = MIL-STD-188-182 1 = MIL-STD-188-182A 2-15 = Reserved	Version of a controller that can control terminals complying with all capabilities of this version of the standard
Total Size	48		

NOTE: This is sent by the PCC in response to a login request (ROWs 2 and 6) from a network member. This FOW announces the network members service restriction (maximum transmit precedence allowed where the minimum possible precedence is routine and the maximum possible precedence is flash override).

TABLE B-VIII. FOW:Logout Response message.

FIELD	BITS	VALUE	NOTES
Message Type	6	7	
Source Address	16		Source node address
Reason	3	0 = Terminal requested logout 1 = PCC directed logout 2 = Not authorized 3 = Invalid address on guard list 4 = Response to service request if not logged in 5-7 = Reserved	
Total Size	25		

NOTE: This is sent by the PCC in response to a logout request (ROW 7) from a network member.

TABLE B-IX. FOW:Message Acknowledgment message.

FIELD	BITS	VALUE	NOTES
Message Type	6	8	
Source Address	16		Source node address
Destination Address	16		Destination node address
Virtual Port	3	0-4 = Demand assigned 5-7 = Reserved	Unique request identifier
Acknowledgment Type	1	0 = All blocks transferred 1 = Message transferred	Value = 1 indicates message was clocked out to destination I/O device
Total Size	42		

NOTE: This is sent by the PCC to the source of a message service identifying that the destination has acknowledged the receipt of the message. This FOW also tears down the message service when the Acknowledgment Type field is set to binary 1.

TABLE B-X. FOW:Message Assignment message.

FIELD	BITS	VALUE	NOTES
Message Type	6	9	
Source Address	16		Source node address
Destination	16		Destination node or subnet address
Virtual Port	3	0-4 = Demand assigned 5-7 = Reserved	Unique request identifier
Precedence	3	0 = Reserved 1 = Flash Override 2 = Flash 3 = Immediate 4 = Priority 5 = Routine 6,7 = Reserved	
Starting Block Number	9	0 = First block 1 = Second block . . . 511 = 512th block	Identifies the first 224-bit data block for the assigned transmission
Number of Blocks	5		Number of blocks being transmitted (between 1 and 20).
Last Block Indicator	1	0 = Not last block 1 = Last block	This transmission includes the last block if the value = 1
Coding	1	0 = No error correction encoding 1 = Error correction encoding	

TABLE B-X. FOW:Message Assignment message (Concluded).

FIELD	BITS	VALUE	NOTES
Modulation and Coding Rate	4	0 = 600 sps See Note 2 1 = 1200 sps See Note 2 2 = 2400 sps See Note 2 3 = 3000 sps See Note 2 4 = 600 sps Rate 3/4 5 = 1200 sps Rate 3/4 6 = 2400 sps Rate 3/4 7 = 3000 sps Rate 3/4 8 = Reserved 9 = Reserved 10 = Reserved 11 = 3000 sps Rate 7/8 12-15 = Reserved	See Note 2
Encrypted Data	1	0 = Encrypted data 1 = Data not encrypted	
Total Size	65		

NOTES:

1. This is sent by the PCC in response to a request (ROW 9) from a network member to setup a message service. This FOW assigns communications time slot and other parameters of the communications.
2. For values 0, 1, 2, and 3 in the Modulation and Coding Rate field the value in the Coding field will indicate whether code rate 1 or 1/2 is employed. If Coding field has value 0 code rate 1 is used and if value 1 rate 1/2 is used. For values 4, 5, 7, and 10 in the Modulation and Coding Rate field the value in Coding field will be set to 1.

TABLE B-XI. FOW:Message Setup Response message.

FIELD	BITS	VALUE	NOTES
Message Type	6	10	
Source Address	16		Source node address
Destination Address	16		Destination node or subnet address
Virtual Port	3	0-4 = Demand assigned 5-7 = Reserved	Unique request identifier
Request Status	4	0 = Queued, local 1 = Rejected, terminal access restriction violation 2 = Rejected, system access restriction violation 3 = Rejected, no capacity 4 = Rejected, destination not logged in 5 = Rejected, no multiple-hop resources available 6 = Queued, multiple-hop 7 = Reserved 8 = Reserved 9 = Rejected, network isolated 10-11 = Reserved 12 = Rejected, service not assignable 13 = Rejected, frequency switching incompatibility 14-15 = Reserved	
Total Size	45		

NOTE: This is sent by the PCC in response to a request (ROW 9) from a network member to setup a message service. This FOW announces if the message service is queued or why the service request is rejected.

TABLE B-XII. FOW:Message Teardown message.

FIELD	BITS	VALUE	NOTES
Message Type	6	11	
Source Address	16		Source node address
Destination Address	16		Destination node or subnet address
Virtual Port	3	0-4 = Demand assigned 5-7 = Reserved	Unique request identifier
Reason	4	0 = Operator requested teardown 1 = Participant not logged in 2 = Preemption timeout 3 = Queued service timeout 4 = Reserved 5 = Precedence override 6 = Unacknowledge message delivery 7 = Reserved 8 = Reserved 9 = Unknown service 10 = Reserved 11 = CS operator requested teardown 12-15 = Reserved	
Total Size	45		

NOTE: This is sent by the PCC to teardown a message service. This FOW announces why the message service is being torn down.

TABLE B-XIII. FOW:Multiple-Hop Begin Assignments Response message.

FIELD	BITS	VALUE	NOTES
Message Type	6	12	
Relay Address	16		Addressee of FOW message
Service Source Address	16		Node address of service source
Virtual Port	3	0-4 = Demand assigned 5 = Preassigned 6,7 = Reserved	Unique request identifier
Total Size	41		

NOTE: This is sent in response to the ACC (ROW 11) by the PCC in a local footprint.

TABLE B-XIV. FOW:Multiple-Hop Circuit Assignment message.

FIELD	BITS	VALUE	NOTES
Message Type	6	13	
Local Source Address	16		Local source node address to which the assignment is directed.
Local Destination Address	16		Local destination node address to which the assignment is directed.
Service Source Address	16		Node address of service source
Virtual Port	3	0-4 = Demand assigned 5 = Preassigned 6,7 = Reserved	Unique request identifier
Circuit Type	1	0 = Data 1 = Voice	
Asynchronous Service Indicator	1	0 = Synchronous User I/O 1 = Asynchronous User I/O	
Precedence	3	0 = Preassigned 1 = Flash Override 2 = Flash 3 = Immediate 4 = Priority 5 = Routine 6,7 = Reserved	
Duplex	2	0 = Half-duplex 1 = Full-duplex, source-to-destination 2 = Full-duplex, destination-to-source 3 = Reserved	Defines communications capability (half- or full-duplex) and, in the case of full-duplex, the direction assignment for the time slot.

TABLE B-XIV. FOW:Multiple-Hop Circuit Assignment message (Concluded).

FIELD	BITS	VALUE	NOTES
I/O Data Rate and Burst Format Type	4	0 = 75 bps 1 = 300 bps 2 = 600 bps 3 = 1200 bps 4 = 2400 bps, data/fixed voice 5 = 2400 bps, subframed voice 6-15 = Reserved	
Coding	1	0 = No error correction encoding 1 = Error correction encoding	
Modulation and Coding Rate	4	0 = 600 sps (See Note 2) 1 = 1200 sps (See Note 2) 2 = 2400 sps (See Note 2) 3 = 3000 sps (See Note 2) 4 = 600 sps Rate 3/4 5 = 1200 sps Rate 3/4 6 = 2400 sps Rate 3/4 7 = 3000 sps Rate 3/4 8-10 = Reserved 11 = 3000 sps Rate 7/8 12-15 = Reserved	See Note 2
Encrypted Data	1	0 = Encrypted data 1 = Data not encrypted	
Total Size	74		

NOTES:

1. This is sent by the PCC in a local footprint telling the source and the destination network members that a multiple-hop circuit is setup. This FOW assigns communications time slot and other parameters of the communications. This message is also sent in response to ROWS 4 and 13.

2. For values 0, 1, 2, and 3 in the Modulation and Coding Rate field the value in the Coding field will indicate whether code rate 1 or 1/2 is employed. If Coding field has value 0, code rate 1 is used and if value 1, rate 1/2 is used. For values 4, 5, 7, and 10 in the Modulation and Coding Rate field the value in Coding field will be set to 1.

TABLE B-XV. FOW:Multiple-Hop Circuit Preemption Response message.

FIELD	BITS	VALUE	NOTES
Message Type	6	14	
Relay Address	16		Addressee of the FOW message
Service Source Address	16		Node address of service source
Virtual Port	3	0-4 = Demand assigned 5-7 = Reserved	Unique request identifier
Total Size	41		

NOTE: This is sent by the PCC in a local footprint responding to the relay's preemption ROW (ROW 12).

TABLE B-XVI. FOW:Multiple-Hop Service Teardown message.

FIELD	BITS	VALUE	NOTES
Message Type	6	15	
Local Source Address	16		Local source node address to which the assignment is directed.
Local Destination Address	16		Local destination node address to which the assignment is directed
Service Source Address	16		Node address of service source
Virtual Port	3	0-4 = Demand assigned 5 = Preassigned 6,7 = Reserved	Unique request identifier
Reason	4	0 = Operator requested teardown 1 = Participant not logged in 2 = Preemption timeout 3 = Queued service timeout 4 = Multiple-hop setup failed 5 = Precedence override 6 = Unacknowledged message delivery 7 = End-to-end bit timing loss 8 = I/O data rate incompatible 9 = Unknown service 10 = Loss of path connectivity 11 = CS operator requested teardown 12 = Destination not found within maximum number of hops 13 = Multiple preemptions 14 = Unused circuit timeout 15 = M-hop message ACK	
Total Size	61		

NOTE: This FOW is initiated by the PCC to teardown a multiple-hop service. This FOW announces why the multiple-hop service is being torn down. This also assigns ROW capacity for the response (ROW 15). This FOW is also sent by the PCC in response to a ROW 14.

TABLE B-XVII. FOW:Network Status message.

FIELD	BITS	VALUE	NOTES
Message Type	6	16	
Relay Address	16		Address of CC to which this is directed.
CC Address	16		Address of CC that originated the message
Control Transition Indicator	1	0 = No 1 = Yes	
Local Relay Connectivity	1	0 = Isolated 1 = Connected	
Remote Relay Connectivity	1	0 = Isolated 1 = Connected	
Hops Traversed	2	0 = 1 hop 1 = 2 hops 2 = 3 hops 3 = 4 hops	Distance to originator of network status message (that is, the number of hops).
Total Size	43		

NOTE: This FOW is sent by the PCC to the ACC for notification of the other CCs throughout the global network when the network status of a CC changes. This also assigns ROW capacity for the response (ROW 17).

TABLE B-XVIII. FOW:Network Status Response message.

FIELD	BITS	VALUE	NOTES
Message Type	6	17	
Relay Address	16		Address of CC to which this is directed.
PCC Address	16		Address of PCC that originated the message.
Total Size	38		

NOTE: This FOW is sent by the PCC to acknowledge receipt from the ACC (ROW #16) about the network status of a remote CC (one not in the local footprint).

TABLE B-XIX. FOW:Null Assignment message.

FIELD	BITS	VALUE	NOTES
Message Type	6	18	
Total Size	6		

NOTE: This FOW assigns a communications time slot of 32 building blocks in the communications segment of the frame. This FOW is used to prevent overlapping transmit and receive assignments to half-duplex terminals.

TABLE B-XXa. FOW:Participant Status Data Base message.

FIELD	BITS	VALUE	NOTES
Message Type	6	19	
End Indicator	1	0 = No 1 = Yes	Provides indication of the last data-base block.
Participant Status Vector	80		This 80-bit participant status vector is subdivided into 4 identical 20-bit segments. The configuration of each segment is shown in Table 20-XXb.
Terminal Standard Version	4	0 = MIL-STD-188-182 1 = MIL-STD-188-182A 2-15 = Reserved	Version of a controller that can control terminals that comply with all capabilities of this version of the standard
Total Size	91		

NOTE: This FOW message is sent by an PCC immediately following a control transition. This FOW message provides active/queued service status for up to four logged-in terminals. The PCC sends five messages per frame until the status has been provided for all locally logged-in terminals, except that fewer than five messages may be sent in the last frame in which such messages are sent.

TABLE B-XXb. FOW:Participant status vector segment format.

SUBFIELD	BITS	VALUE	NOTES
Node Address	16	0 = Address not applicable 1-65,535 = Address	Node address of the logged-in network participant to which the address word applies.
Active/Queued Service Status	3	0 = No active/queued services 1 = One active/queued service 2 = Two active/queued services 3 = Three active/queued services 4 = Four active/queued services 5 = Five active/queued services 6,7 = Reserved	Number of active or queued services for which the network participant is the demand assigned service source.
Silent Terminal	1	0 = No 1 = Yes	

TABLE B-XXI. FOW:Primary Channel Controller Designate message.

FIELD	BITS	VALUE	NOTES
Message Type	6	20	
Status Report Polling Frequency	2	0 = 5 minutes 1 = 10 minutes 2 = 20 minutes 3 = 40 minutes	Control transition data base item
Queued Service Timeout	11	0-6 = Reserved 7-805 = Timeout value in frames 806-2047 = Reserved	Control transition data base item
Queued Multiple-Hop Service Timeout	11	0-6 = Reserved 7-1342 = Timeout value in frames 1343-2047 = Reserved	Control transition data base item
Unused Service Timeout	11	0-6 = Reserved 7-1342 = Timeout value in frames 1343-2047 = Reserved	Control transition data base item
Minimum Contention ROWs	5	0 = Reserved 1-20 = Minimum number of contention ROW time slots per frame 21-31 = Reserved	Control transition data base item
Multiple Hop Limit	2	0 = 1 hop (local service only) 1 = 2 hops 2 = 3 hops 3 = 4 hops	Control transition data base item
Total Size	48		

NOTE: This is sent by the PCC to an ACC to assume channel control. This also assigns ROW capacity for the response (ROW 19).

TABLE B-XXII. FOW:Ranging Assignment message.

FIELD	BITS	VALUE	NOTES
Message Type	6	21	
Source Address	16		Source node address identifying the terminal to which the assignment is made.
Total Size	22		

NOTE: This FOW assigns a ROW time slot of 32 building blocks for use by the identified network member for active ranging. This message is also sent in response to ROW:Assign Ranging (ROW 1).

TABLE B-XXIII. FOW:Relay Ringup message.

FIELD	BITS	VALUE	NOTES
Message Type	6	22	
Relay Address	16		CC to which the message is directed.
Service Source Address	16		Source node address
Service Destination Address	16		Destination node address
Virtual Port	3	0-4 = Demand assigned 5 = Preassigned 6,7 = Reserved	Unique request identifier
Service Type	1	0 = Circuit 1 = Message	
Circuit Type	1	0 = Data 1 = Voice	
Asynchronous Service Indicator	1	0 = Synchronous User I/O 1 = Asynchronous User I/O	
Precedence	3	0 = Preassigned 1 = Flash Override 2 = Flash 3 = Immediate 4 = Priority 5 = Routine 6,7 = Reserved	
Duplex	1	0 = Half-duplex 1 = Full-duplex	
I/O Data Rate	4	0 = 75 bps 1 = 300 bps 2 = 600 bps 3 = 1200 bps 4 = 2400 bps 5-15 = Reserved	
Multiple-Hop Limit	1		
Encrypted Data			
Total Size	71	0 = Encrypted data 1 = Data not encrypted	

NOTE: This FOW is used to pass multiple-hop service parameters to the ACC for relay into the adjacent network. ROW capacity is assigned for the ROW:Relay Ringup Response message (ROW 21).

TABLE B-XXIV. FOW:Relay Ringup Response message.

FIELD	BITS	VALUE	NOTES
Message Type	6	23	
Relay Address	16		CC to which the message is directed.
Service Source Address	16		Source node address
Virtual Port	3	0-4 = Demand assigned 5 = Preassigned 6,7 = Reserved	Unique request identifier
Total Size	41		

NOTE: This FOW is sent to acknowledge receipt of a request for multiple-hop service setup (ROW 20) by a remote control station.

TABLE B-XXV. FOW:Relay Select message.

FIELD	BITS	VALUE	NOTES
Message Type	6	24	
Relay Address	16		CC to which the message is directed.
Service Source Address	16		Source node address
Virtual Port	3	0-4 = Demand assigned 5 = Preassigned 6,7 = Reserved	Unique request identifier
Hops Traversed	2	0 = 1 hop 1 = 2 hops 2 = 3 hops 3 = 4 hops	Distance to originator of the relay select (that is, the number of hops).
Request Status	4	0 = Accepted 1 = Rejected, loss in path connectivity 2 = Rejected, destination not found within maximum number of hops 3 = Rejected, no CC capacity 4 = Rejected, no relay capacity 5 = Rejected, I/O data rate incompatible 6 = Rejected, system service restriction violation 7 = Rejected, system access restriction violation 8 = Rejected, destination busy 9-15 = Reserved	
Total Size	47		

NOTE: This FOW is a response to a ROW:Relay Ringup message (ROW 20) and is used to accept or reject a multiple-hop service request. ROW capacity is assigned for the ROW:Relay Select Response message (ROW 23).

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TABLE B-XXVI. FOW:Relay Select Response message.

FIELD	BITS	VALUE	NOTES
Message Type	6	25	
Relay Address	16		CC to which the message is directed.
Service Source Address	16		Source node address
Virtual Port	3	0-4 = Demand assigned 5 = Preassigned 6,7 = Reserved	Unique request identifier
Total Size	41		

NOTE: This FOW is a response to ROW 22.

TABLE B-XXVII. FOW:Report Status message.

FIELD	BITS	VALUE	NOTES
Message Type	6	26	
Source Address	16		Source node address identifying the terminal from which a status report is requested.
Total Size	22		

NOTE: This FOW is sent by the PCC to a network member requesting a status report from the member. This also assigns ROW capacity for the response (ROW 3 or ROW 24).

TABLE B-XXVIII. FOW:Report Terminal Address message.

FIELD	BITS	VALUE	NOTES
Message Type	6	27	
Source Address	16		Source node address identifying the network participant from which an address guard-list report is requested.
Guard List Index	3	0 = Report first three guard list addresses 1 = Report second three guard list addresses 2 = Report third three guard list addresses 3 = Report fourth three guard list addresses 4 = Report last three guard list addresses 5-7 = Reserved	Specifies which guard list addresses to report, in blocks of three (the terminal or CC node address is not reported in this field)
Total Size	25		

NOTE: This FOW is sent by the PCC to a network member requesting a report of guard list addresses from the member. This also assigns ROW capacity for the response (ROW 26).

TABLE B-XXIX. FOW:Terminal Address Add or Delete message.

FIELD	BITS	VALUE	NOTES
Message Type	6	28	
Source Address	16		Source node address identifying the terminal for which the guard list is to be updated.
Modification	1	0 = Add address 1 = Delete address	
Address	16		Address (node or subnet identifier) to be added or deleted.
Total Size	39		

NOTE: This FOW is sent by the PCC to a network member requesting an addition or deletion to the guard list addresses of the member. This also assigns ROW capacity for the response (ROW 25).

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TABLE B-XXX. FOW:Terminal Channel Assignment - 182 message.

FIELD	BITS	VALUE	NOTES
Message Type	6	29	
Node Address	16		Address of terminal that is to change channels
Source Address	16		The original requestor of the channel re-assignment
Channel	8	See Appendix D for Channel numbers	
Circuit Type	1	0 = Data 1 = Voice	NOTE 1
Asynchronous Service Indicator	1	0 = Synchronous User I/O 1 = Asynchronous User I/O	NOTE 1
I/O Data Rate	4	0 = 75 bps 1 = 300 bps 2 = 600 bps 3 = 1200 bps 4 = 2400 bps 5 = 4800 bps 6 = 6400 bps 7 = 9.6 kbps 8 = 16 kbps 9 = 19.2 kbps 10 = 32 kbps 11 = 38.4 kbps 12-15 = Reserved	NOTE 1
Encrypted Data	1	0 = Encrypted data 1 = Data not encrypted	NOTE 1
Configuration Code	9	0 = Not Applicable 1-511 = Operationally Assigned	
Channel Type	1	0 = DAMA 1 = Single access	
Channel Duration	10	0 = Unlimited 1 = 5 minutes 2 = 10 minutes 3 = 15 minutes . . . 1023 = 5115 minutes	
Total Size	73		

NOTES:

1. This field is valid only when the channel type has value of 1.
2. This FOW is sent to a MIL-STD-188-182 compliant network member instructing the member to move to a different channel of operation and/or a different mode of operation. This FOW is not applicable to MIL-STD-188-182A compliant terminals. However, it could be used by MIL-STD-188-182A compliant terminals to correctly interpret the FOW directed messages. This message is also sent in response to ROW 4 and also assigns ROW capacity for the response (ROW 27).

TABLE B-XXXI. FOW:Contention Response message.

FIELD	BITS	VALUE	NOTES
Message Type	6	30	
Source Address	16		Returning terminal's node address
Total Size	22		

NOTE: This FOW is a response to ROWs 3, 24, 28.

TABLE B-XXXII. FOW:Zeroize message.

FIELD	BITS	VALUE	NOTES
Message Type	6	31	
Length	7	46 = 47 bits	Length of this message in bits, including all mandatory fields plus directed message fields
ROW Assignment	1	0 = No assigned ROW slot	
Communications Assignment	1	0 = No assigned communications slot	
Address 1	16		Terminal node address to which zeroize command is directed
Address 2	16		Terminal node address to which zeroize command is directed. If this field does not match Address 1 field, the terminal shall ignore the command.
Total Size	47		

NOTE: This FOW is sent by the PCC to a network member to direct it to zeroize all of its key storage memory.

TABLE B-XXXIII. FOW:Terminal Channel Assignment - 182A message.

FIELD	BITS	VALUE	NOTES
Message Type	6	32	
Length	7	87 = 88 bits	Length of this message in bits, including all mandatory fields plus directed message fields
ROW Assignment	1	0 = No assigned ROW time slot	
Communications Assignment	1	0 = No assigned communications time slot	
Node Address	16		Address of terminal that is to change channels
Source Address	16		The original requestor of the channel re-assignment
Virtual Port	3	0-4 = Demand Assigned 5 = Preassigned 6, 7 = Reserved	Unique request identifier
Channel	8	See Appendix D for Channel numbers	
Circuit Type	1	0 = Data 1 = Voice	NOTE 1
Precedence	3	0 = Preassigned 1 = Flash Override 2 = Flash 3 = Immediate 4 = Priority 5 = Routine 6, 7 = Reserved	
Asynchronous Service Indicator	1	0 = Synchronous User I/O 1 = Asynchronous User I/O	NOTE 1

TABLE B-XXXIII. FOW:Terminal Channel Assignment - 182A message. (concluded)

FIELD	BITS	VALUE	NOTES
I/O Data Rate	4	0 = 75 bps 1 = 300 bps 2 = 600 bps 3 = 1200 bps 4 = 2400 bps 5 = 4800 bps 6 = 6000 bps 7 = 9.6 kbps 8 = 16 kbps 9 = 19.2 kbps 10 = 32 kbps 11 = 38.4 kbps 12-15 = Reserved	NOTE 1
Encrypted Data	1	0 = Encrypted data 1 = Data not encrypted	NOTE 1
Configuration Code	9	0 = Not Applicable 1-511 = Operationally Assigned	
Channel Type	1	0 = DAMA 1 = Single access	
Channel Duration	10	0 = Unlimited 1 = 5 minutes 2 = 10 minutes 3 = 15 minutes . . . 1023 = 5115 minutes	
Total Size	88		

NOTES:

1. This field is valid only when the channel type has value of 1.
2. This FOW is sent to a MIL-STD-188-182A compliant network member instructing the member to move to a different channel of operation and/or a different mode of operation. This message is also sent in response to ROW 4 and also assigns ROW capacity for the response (ROW 27).

TABLE B-XXXIV. Future FOWs.

FIELD	BITS	VALUE	NOTES
Message Type	6	33-63	
Length	7	0-13 = Invalid 14 = 15 bits 15 = 16 bits . . . 127 = 128 bits	Length of this message in bits, including all mandatory fields plus directed message fields
ROW Assignment	1	0 = No assigned ROW time slot 1 = Assigned ROW time slot	
Communications Assignment	1	0 = No assigned communications time slot 1 = Assigned communications time slot	
Communications Slot Size	10	0 = One building block 1 = Two building blocks . . . 1023 = 1024 building blocks	Number of building blocks assigned (does not exist if Communications Assignment field equals zero)
Directed Message Fields	Variable		To be completed as future FOWs are developed
Total Size	Variable		

NOTE: Mandatory fields required in all future FOWs to allow existing terminals to parse the FOW, ROW, and communications segments.

APPENDIX C

ROW MESSAGES

C.1 SCOPE

This Appendix is a mandatory part of this standard. The information contained herein is intended for compliance. The Message field for each return orderwire (ROW) message transmitted to a controller is specified. The ROW message field is discussed in 5.1.2.2 e. The bits within each field and the meaning assigned to each binary number is provided. Each terminal shall be capable of transmitting each of the messages defined in this appendix except for those defined in Tables C-3, C-4, C-12, C-13 through C-18, and C-20 which are used by controllers.

C.2 CONTENTS

The ROW messages included in this appendix are as follows:

TABLE C-I. ROW:Alternate Channel Controller Designate message.

FIELD	BITS	VALUE	NOTES
Message Type	6	0	
Retry Flag	1	0 = First Attempt 1 = Retry	Indicates whether the particular ROW message is being sent the first time or as a second attempt (retry).
Reserved Bits	53	0	All bits set to zero
Total Size	60		

NOTE: A request from the ACC to assume channel control. The PCC responds with a FOW 2.

TABLE C-II. ROW:Assign Ranging message.

FIELD	BITS	VALUE	NOTES
Message Type	6	1	
Retry Flag	1	0 = First attempt 1 = Retry	Indicates whether the particular ROW message is being sent the first time or as a second attempt (retry).
Reserved Bits	53	0	All bits set to zero
Total Size	60		

NOTE: A request from a network member to be assigned a ranging time slot. The PCC responds with a FOW 21.

TABLE C-III. ROW:Channel Controller Login message.

FIELD	BITS	VALUE	NOTES
Message Type	6	2	
I/O Data Rate	16	Binary 0000000000000001 = 75 bps * 0000000000000010 = 300 bps * 0000000000000100 = 600 bps * 0000000000001000 = 1200 bps * 0000000000010000 = 2400 bps * 0000000000100000 = 4800 bps 0000000001000000 = 6400 bps 0000000010000000 = 9.6 kbps 0000000100000000 = 16 kbps 0000001000000000 = 19.2 kbps 0000010000000000 = 32 kbps 0000100000000000 = 38.4 kbps 0001000000000000 = Reserved 0010000000000000 = Reserved 0100000000000000 = Reserved 1000000000000000 = 2.4 kbps * voice	The OR value of all supportable rates is to be sent. The rates above 2400 bps are only for MIL-STD-188-181 operation. *Mandatory
Link Quality	6	0 = 26.0 dB-Hz 1 = 26.5 dB-Hz • • • 62 = 57.0 dB-Hz 63 = 57.5 dB-Hz	Downlink C/N_o in dB-Hz.
Guard List Size	4	0-15	Size of guard list, not including CC node address
Guard List CRC	16		
Connectivity	1	0 = Connected 1 = Isolated	Indicates whether this CC is connected to its required CC and can support multiple-hop communications
Terminal Type	1	0 = Half-duplex at rf 1 = Full-duplex at rf	This allows the PCC to schedule adjacent transmit and receive time slots

NOTE: Mandatory requirement.

TABLE C-III. ROW:Channel Controller Login message (Concluded).

FIELD	BITS	VALUE	NOTES
Terminal Standard Version	4	Compliant with: 0 = MIL-STD-188-182 1 = MIL-STD-188-182A 2-15 = Reserved	Highest Version of MIL-STD that the CC complies with
Ranging Type	1	0 = Active 1 = Passive	Indicates ranging mode for assigned ranging
Retry Flag	1	0 = First attempt 1 = Retry	Indicates whether the particular ROW message is being sent the first time or as a second attempt (retry).
Reserved Bits	4	0	All bits set to zero
Total Size	60		

NOTE: A login request from a ACC to join the network. The PCC responds with a FOW 6.

TABLE C-IV. ROW:Channel Controller Status Report message.

FIELD	BITS	VALUE	NOTES
Message Type	6	3	
I/O Data	16	Binary 0000000000000001 = 75 bps 0000000000000010 = 300 bps 0000000000000100 = 600 bps 0000000000001000 = 1200 bps 0000000000010000 = 2400 bps 0000000000100000 = 4800 bps 0000000001000000 = 6400 bps 0000000010000000 = 9.6 kbps 0000000100000000 = 16 kbps 0000001000000000 = 19.2 kbps 0000010000000000 = 32 kbps 0000100000000000 = 38.4 kbps 0001000000000000 = 2.4 kbps 0010000000000000 Reserved 0100000000000000 = Reserved 1000000000000000 = 2.4 kbps voice	The OR value of all supportable rates is to be sent. The rates above 2400 bps are only for MIL-STD-188-181 operation.
Link Quality	6	0 = 26.0 dB-Hz 1 = 26.5 dB-Hz ● ● ● 62 = 57.0 dB-Hz 63 = 57.5 dB-Hz	Downlink C/N_o in dB-Hz.
Guard List Size	4	0-15	Size of guard list, not including CC node address.
Guard List CRC	16		
Connectivity	1	0 = Connected 1 = Isolated	Indicates whether this CC is connected to required CC and can support multiple-hop communications.

TABLE C-IV. ROW:Channel Controller Status Report message (Concluded).

FIELD	BITS	VALUE	NOTES
Terminal Type	1	0 = Half-duplex at rf 1 = Full-duplex at rf	This allows the PCC to schedule adjacent transmit and receive time slots.
Terminal Standard Version	4	Compliant with 0 = MIL-STD-188-182 1 = MIL-STD-188-182A 2-15 = Reserved	Highest version of MIL-STD the CC complies with.
Ranging Type	1	0 = Active 1 = Passive	
Retransmission Flag	1	0 = No retransmission difficulty 1 = Retransmission difficulty	
25-kHz Standard Version	4	0 = 25-kHz disabled 1 = MIL-STD-188-183 2 = MIL-STD-188-183A 3-11 = Reserved	
Total Size	60		

NOTE: A status report from a ACC in response to a status report request (FOW 26).

TABLE C-V. ROW:Circuit Setup message.

FIELD	BITS	VALUE	NOTES
Message Type	6	4	
Destination Address	16		Destination node or subnet address
Virtual Port	3	0-4 = Demand assigned 5-7 = Reserved	Unique request identifier
Circuit Type	1	0 = Data 1 = Voice	
Asynchronous Service Indicator	1	0 = Synchronous User I/O 1 = Asynchronous User I/O	
Precedence	3	0 = Reserved 1 = Flash Override 2 = Flash 3 = Immediate 4 = Priority 5 = Routine 6,7 = Reserved	
Duplex	1	0 = Half-duplex 1 = Full-duplex	Used only when Single Access Channel Indicator = 0
I/O Data Rate	4	0 = 75 bps 1 = 300 bps 2 = 600 bps 3 = 1200 bps 4 = 2400 bps 5 = 4800 bps 6 = 6400 bps 7 = 9.6 kbps 8 = 16 kbps 9 = 19.2 kbps 10 = 32 kbps 11 = 38.4 kbps 12-15 = Reserved	Rates above 2400 bps are not available on 5-kHz DAMA channels
Encrypted Data	1	0 = Encrypted data 1 = Data not encrypted	
Retry Flag	1	0 = First attempt 1 = Retry	Indicates whether the particular ROW message is being sent the first time or as a second attempt (retry).

TABLE C-V. ROW:Circuit Setup Message (Concluded).

FIELD	BITS	VALUE	NOTES
Global Search	1	0 = Off 1 = On	If off, setup is limited to local footprint and . Available only on 5-kHz DAMA Channels
Channel Type	1	0 = 5 kHz 1 = 25 kHz	
Single-Access Channel Indicator	1	0 = Not a request for a single-access channel 1 = Request for single- access channel	
Configuration Code	9	0 = Not Applicable 1-511 = Operationally Assigned	
Channel Duration	10	0 = Unlimited 1 = 5 minutes 2 = 10 minutes 3 = 15 minutes . . . 1023 = 5115 minutes	Used only when Single-Access Channel Indicator = 1
Reserved Bits	1	0	All bits set to zero
Total Size	60		

NOTE: A request from a network member to setup a circuit service. The PCC responds with either FOW 3 or FOW 4 or FOW 13 or FOW 32.

TABLE C-VI. ROW:Circuit Teardown message.

FIELD	BITS	VALUE	NOTES
Message Type	6	5	
Source Address	16		Source node address identifying the terminal that requested circuit setup.
Destination Address	16		Destination node address
Virtual Port	3	0-4 = Demand assigned 5-7 = Reserved	Unique request identifier
Reason	4	0 = Operator requested teardown 1 = Reserved 2 = Reserved 3 = Reserved 4 = Reserved 5 = Precedence override 6 = Destination Busy 7 = End-to-end bit timing loss 8 = I/O data rate incompatible 9 = Unknown service 10-15 = Reserved	
Retry Flag	1	0 = First Attempt 1 = Retry	Indicates whether the particular ROW message is being sent the first time or as a second attempt (retry).
Reserved Bits	14	0	All bits set to zero
Total Size	60		

NOTE: A request from a network member to teardown a queued or active circuit service. The PCC responds with a FOW 5.

TABLE C-VII. ROW:Login message.

FIELD	BITS	VALUE	NOTES
Message Type	6	6	
I/O Data Rate	16	Binary 0000000000000001 = 75 bps * 0000000000000010 = 300 bps * 0000000000000100 = 600 bps * 0000000000001000 = 1200 bps * 0000000000010000 = 2400 bps * 0000000000100000 = 4800 bps 0000000001000000 = 6400 bps 0000000010000000 = 9.6 kbps 0000000100000000 = 16 kbps 0000001000000000 = 19.2 kbps 0000010000000000 = 32 kbps 0000100000000000 = 38.4 kbps 0001000000000000 = Reserved 0010000000000000 Reserved 0100000000000000 = Reserved 1000000000000000 = 2.4 kbps * voice	The OR value of all supportable rates is to be sent. The rates above 2400 bps are only for MIL-STD-188-181 operation. *Mandatory
Link Quality	6	0 = 26.0 dB-Hz 1 = 26.5 dB-Hz • • • 62 = 57.0 dB-Hz 63 = 57.5 dB-Hz	Downlink C/N_o in dB-Hz.
Guard List Size	4	0-15	Size of guard list, not including terminal node address.
Guard List CRC	16		
Terminal Type	1	0 = Half-duplex at rf 1 = Full-duplex at rf	Allows the PCC to schedule adjacent transmit and receive time slots

TABLE C-VII. ROW: Login message (concluded).

FIELD	BITS	VALUE	NOTES
Silent Terminal Indicator	1	0 = No 1 = Yes	Indicates whether the terminal wished to be considered a Silent Terminal
Terminal Standard Version	4	Compliant with: 0 = MIL-STD-188-182 1 = MIL-STD-188-182A 2-15 = Reserved	Highest Version of MIL-STD that the terminal complies with
Automatic Frequency Change Capability	1	0 = No 1 = Yes	Indicates whether the terminal can participate in multiple channel operation
Ranging Flag	1	0 = Active 1 = Passive	Indicates ranging mode
Retry Flag	1	0 = First Attempt 1 = Retry	Indicates whether the ROW message is being sent for the first time or is a retry.
25-kHz Standard Version	3	0 = MIL-STD-188-183 disabled 1 = MIL-STD-188-183 2 = MIL-STD-188-183A 3-7 = Reserved	
Total Size	60		

NOTE: A login request from a terminal to join the network. The PCC responds with a FOW 6.

TABLE C-VIII. ROW:Logout message.

FIELD	BITS	VALUE	NOTES
Message Type	6	7	
Retry Flag	1	0 = First Attempt 1 = Retry	Indicates whether the particular ROW message is being sent the first time or as a second attempt (retry).
Reserved Bits	53	0	Set all bits to zero
Total Size	60		

NOTE: A logout request from a terminal to leave the network. The PCC responds with a FOW 7.

TABLE C-IX. ROW:Message Acknowledgment message.

FIELD	BITS	VALUE	NOTES
Message Type	6	8	
Source Address	16		Source node address
Destination Address	16		Destination node address
Virtual Port	3	0-4 = Demand assigned 5-7 = Reserved	Unique request identifier
Retransmission Flag	1	0 = No retransmission difficulty 1 = Retransmission difficulty	
Reserved Bits	18	0	Set all bits to zero
Total Size	60		

NOTE: A response to a request from the PCC (FOW 0) that means that the message was transferred to the network member's I/O device.

TABLE C-X. ROW:Message Setup message.

FIELD	BITS	VALUE	NOTES
Message Type	6	9	
Destination Address	16		Destination node address
Virtual Port	3	0-4 = Demand assigned 5-7 = Reserved	Unique request identifier
Precedence	3	0 = Reserved 1 = Flash Override 2 = Flash 3 = Immediate 4 = Priority 5 = Routine 6,7 = Reserved	
Message Length in Data Blocks	9	0 = One block 1 = Two blocks . . . 511 = 512 blocks	Length of message in 224-bit data blocks.
Encrypted Data	1	0 = Encrypted data 1 = Data not encrypted	
Retry Flag	1	0 = First attempt 1 = Retry	Indicates whether the particular ROW message is being sent the first time or as a second attempt (retry).
Global Search	1	0 = Off 1 = On	If off, setup is limited to footprints between local footprint and "home footprint" (expected location).
Reserved Bits	20	0	Set all bits to zero
Total Size	60		

NOTE: A request from a network member to setup a message service. The PCC responds with either a FOW 9 or FOW 10.

TABLE C-XI. ROW:Message Teardown message.

FIELD	BITS	VALUE	NOTES
Message Type	6	10	
Source Address	16		Source node address
Destination Address	16		Destination node or subnet address
Virtual Port	3	0-4 = Demand assigned 5-7 = Reserved	Unique request identifier
Reason	4	0 = Operator requested teardown 1 = Reserved 2 = Reserved 3 = Reserved 4 = Reserved 5 = Precedence override 6 = Destination busy 7 = Reserved 8 = Reserved 9 = Unknown service 10-15 = Reserved	
Retry Flag	1	0 = First attempt 1 = Retry	Indicates whether the particular ROW message is being sent the first time or as a second attempt (retry).
Reserved Bits	14	0	Set all bits to zero
Total Size	60		

NOTE: A request from a network member to teardown a queued or active message service. The PCC responds with a FOW 11.

TABLE C-XII. ROW:Multiple-Hop Begin Assignments message.

FIELD	BITS	VALUE	NOTES
Message Type	6	11	
Service Source Address	16		Source node address
Virtual Port	3	0-4 = Demand assigned 5 = Preassigned 6,7 = Reserved	Unique request identifier
Retry Flag	1	0 = First attempt 1 = Retry	Indicates whether the particular ROW message is being sent the first time or as a second attempt (retry).
Service Type	1	0 = Circuit 1 = Message	
Message Length	9	0 = One block 1 = Two blocks . . . 511 = 512 blocks	
Reserved Bits	24	0	Set all bits to zero
Total Size	60		

NOTE: This is sent by the ACC in a local footprint telling the PCC that the destination footprint is starting to set up the multiple-hop service. The PCC responds with a FOW 12.

TABLE C-XIII. ROW:Multiple-Hop Circuit Preemption message.

FIELD	BITS	VALUE	NOTES
Message Type	6	12	
Service Source Address	16		Source node address
Virtual Port	3	0-4 = Demand assigned 5-7 = Preassigned	Unique request identifier
Retry Flag	1	0 = First attempt 1 = Retry	Indicates whether the particular ROW message is being sent the first time or as a second attempt (retry).
Reserved Bits	34	0	Set all bits to zero
Total Size	60		

NOTE: This is sent by the ACC in a local footprint telling the PCC that the multiple-hop circuit is being preempted. The PCC responds with a FOW 14.

TABLE C-XIV. ROW:Multiple-Hop Circuit Resumption message.

FIELD	BITS	VALUE	NOTES
Message Type	6	13	
Service Source Address	16		Source node address
Virtual Port	3	0-4 = Demand assigned 5-7 = Reserved	Unique request identifier
Retry Flag	1	0 = First attempt 1 = Retry	Indicates whether the particular ROW message is being sent the first time or as a second attempt (retry).
Reserved Bits	34	0	Set all bits to zero
Total Size	60		

NOTE: This is sent by the ACC in a local footprint telling the PCC that the preempted multiple-hop circuit is being resumed. The PCC responds with a FOW 13.

TABLE C-XV. ROW:Multiple-Hop Service Teardown message.

FIELD	BITS	VALUE	NOTES
Message Type	6	14	
Service Source Address	16		Source node address
Virtual Port	3	0-4 = Demand assigned 5 = Preassigned 6,7 = Reserved	Unique request identifier
Reason	4	0 = Operator requested teardown 1 = Participant not logged in 2 = Preemption timeout 3 = Queued service timeout 4 = Multiple-hop setup failed 5 = Precedence override 6 = Reserved 7 = End-to-end bit timing loss 8 = I/O data rate incompatible 9 = Unknown service 10 = Loss of path connectivity 11 = CS operator-requested teardown 12 = Destination not found within maximum number of hops 13 = Multiple preemptions 14 = Unused circuit timeout 15 = M-hop message ACK	
Retry Flag	1	0 = First attempt 1 = Retry	Indicates whether the particular ROW message is being sent the first time or as a second attempt (retry).
Reserved Bits	30	0	All bits set to zero
Total Size	60		

NOTE: This is sent by the ACC in a local footprint telling the PCC that the multiple-hop service is being torn down. The PCC responds with a FOW 15.

TABLE C-XVI. ROW:Multiple-Hop Service Teardown Response message.

FIELD	BITS	VALUE	NOTES
Message Type	6	15	
Service Source Address	16		Source node address
Virtual Port	3	0-4 = Demand assigned 5 = Preassigned 6,7 = Reserved	Unique request identifier
Retransmission Flag	1	0 = No retransmission difficulty 1 = Retransmission difficulty	
Reserved Bits	34	0	Set all bits to zero
Total Size	60		

NOTE: This is sent by the ACC in a local footprint in response to a PCC requesting teardown of a multiple-hop service (FOW 15).

TABLE C-XVII. ROW:Network Status message.

FIELD	BITS	VALUE	NOTES
Message Type	6	16	
CC Address	16		Address of CC that originated the message.
Control Transition Indicator	1	0 = No 1 = Yes	
Local Relay Connectivity	1	0 = Isolated 1 = Connected	
Remote Relay Connectivity	1	0 = Isolated 1 = Connected	
Hops Traversed	2	0 = 1 hop 1 = 2 hops 2 = 3 hops 3 = 4 hops	Distance to originator of network status message (that is, the number of hops).
Retry Flag	1	0 = First attempt 1 = Retry	Indicates whether the particular ROW message is being sent the first time or as a second attempt (retry).
Reserved Bits	32	0	Set all bits to zero
Total Size	60		

NOTE: This ROW is sent by the ACC with information to all other CCs within the local network for notification of the other CCs throughout the global network when the network status of the CC changes. The PCC responds with a FOW:Network Status Response (FOW 17).

TABLE C-XVIII. ROW:Network Status Response message.

FIELD	BITS	VALUE	NOTES
Message Type	6	17	
CC Address	16		Address of CC that originated the message.
Retransmission Flag	1	0 = No retransmission difficulty 1 = Retransmission difficulty	
Reserved Bits	37	0	Set all bits to zero
Total Size	60		

NOTE: This ROW is sent by the ACC to acknowledge receipt of FOW 16.

TABLE C-XIX. ROW:Blocks Acknowledgment message.

FIELD	BITS	VALUE	NOTES
Message Type	6	18	
Service source Address	16		Source node address identifies service source.
Virtual Port	3	0-4 = Demand assigned 5-7 = Reserved	Unique request identifier
Block Number	9	0 = No Blocks received correctly 1 = Block One 2 = Block Two . . . 511 = Block 511	Number of highest contiguous block received (that is, all data in this block and all lower-numbered blocks have been correctly received). Not applicable when All Blocks Received = 1
All Blocks Received	1	0 = No 1 = Yes	
Retransmission Flag	1	0 = No retransmission difficulty 1 = Retransmission difficulty	
Reserved Bits	24	0	Set all bits to zero
Total Size	60		

NOTE: A response to a request from the PCC (FOW 1) that means that the message was received correctly up to a certain block number.

TABLE C-XX. ROW:Primary Channel Controller Designate Response message.

FIELD	BITS	VALUE	NOTES
Message Type	6	19	
Retransmission Flag	1	0 = No retransmission difficulty 1 = Retransmission difficulty	
Reserved Bits	53	0	All bits set to zero
Total Size	60		

NOTE: A response to the PCC (FOW 20) by an ACC to assume channel control.

TABLE C-XXI. ROW:Relay Ringup message.

FIELD	BITS	VALUE	NOTES
Message Type	6	20	
Service Source Address	16		Source node address
Service Destination Address	16		Destination node address
Virtual Port	3	0-4 = Demand assigned 5 = Preassigned 6-7 = Reserved	Unique request identifier
Service Type	1	0 = Circuit 1 = Message	
Circuit Type	1	0 = Data 1 = Voice	
Asynchronous Service Indicator	1	0 = Synchronous User I/O 1 = Asynchronous User I/O	
Precedence	3	0 = Preassigned 1 = Flash Override 2 = Flash 3 = Immediate 4 = Priority 5 = Routine 6,7 = Reserved	
Duplex	1	0 = Half-duplex 1 = Full-duplex	
I/O Data Rate	4	0 = 75 bps 1 = 300 bps 2 = 600 bps 3 = 1200 bps 4 = 2400 bps 5-15 = Reserved	
Multiple-Hop Limit	2	0 = 1 hop 1 = 2 hops 2 = 3 hops 3 = 4 hops	Maximum number of remaining hops allowed (whereby a hop is a radio link through a satellite).
Encrypted Data	1	0 = Encrypted data 1 = Data not encrypted	
Retry Flag	1	0 = First attempt 1 = Retry	Indicates whether the particular ROW message is being sent the first time or as a second attempt (retry).
Reserved Bits	4	0	All bits set to zero
Total Size	60		

NOTE: This ROW is used to determine whether the destination network member is logged into the PCC and identifies the type of service being requested. The PCC responds with a FOW 23.

TABLE C-XXII. ROW:Relay Ringup Response message.

FIELD	BITS	VALUE	NOTES
Message Type	6	21	
Service Source Address	16		Source node address
Virtual Port	3	0-4 = Demand assigned 5 = Preassigned 6-7 = Reserved	
Retransmission Flag	1	0 = No retransmission difficulty 1 = Retransmission difficulty	
Reserved Bits	34	0	All bits set to zero
Total Size	60		

NOTE: This ROW is sent to acknowledge receipt of a request for multiple-hop service setup (FOW 22) by the PCC.

TABLE C-XXIII. ROW:Relay Select message.

FIELD	BITS	VALUE	NOTES
Message Type	6	22	
Service Source Address	16		Source node address
Virtual Port	3	0-4 = Demand assigned 5 = Preassigned 6-7 = Reserved	Unique request identifier
Hops Traversed Flag	2	0 = 1 hop 1 = 2 hops 2 = 3 hops 3 = 4 hops	Distance to originator of the relay select (that is, the number of hops).
Request Status	4	0 = Accepted 1 = Rejected, loss of path connectivity 2 = Rejected, destination not found within maximum number of hops 3 = Rejected, no CC capacity 4 = Rejected, no relay capacity 5 = Rejected, I/O data rate incompatible 6 = Rejected, system service restriction violation 7 = Rejected, system access restriction violation 8 = Rejected, destination busy (preassigned request) 9-15 = Reserved	
Retry Flag	1	0 = First attempt 1 = Retry	Indicates whether the particular ROW message is being sent the first time or as a second attempt (retry).
Reserved Bits	28	0	All bits set to zero
Total Size	60		

NOTE: This ROW identifies if a multiple-hop service is either accepted or rejected. The PCC responds with a FOW 25.

TABLE C-XXIV. ROW:Relay Select Response message.

FIELD	BITS	VALUE	NOTES
Message Type	6	23	
Service Source Address	16		Source node address
Virtual Port	3	0-4 = Demand assigned 5 = Preassigned 6-7 = Reserved	Unique request identifier
Retransmission Flag	1	0 = No retransmission difficulty 1 = Retransmission difficulty	
Reserved Bits	34	0	All bits set to zero
Total Size	60		

NOTE: This ROW is in response to FOW 24 and acknowledges receipt of the FOW.

TABLE C-XXV. ROW:Status Report message.

FIELD	BITS	VALUE	NOTES
Message Type	6	24	
I/O Data Rate	16	Binary 0000000000000001 = 75 bps * 0000000000000010 = 300 bps * 0000000000000100 = 600 bps * 0000000000001000 = 1200 bps * 0000000000010000 = 2400 bps * 0000000000100000 = 4800 bps 0000000001000000 = 6400 bps 0000000010000000 = 9.6 kbps 0000000100000000 = 16 kbps 0000001000000000 = 19.2 kbps 0000010000000000 = 32 kbps 0000100000000000 = 38.4 kbps 0001000000000000 = Reserved 0010000000000000 = Reserved 0100000000000000 = Reserved 1000000000000000 = 2.4 kbps * voice	The OR value of all supportable rates is to be sent. The rates above 2400 bps are not available for 5-kHz DAMA operation. *Mandatory
Link Quality	6	0 = 26.0 dB-Hz 1 = 26.5 dB-Hz • • • 62 = 57.0 dB-Hz 63 = 57.5 dB-Hz	Downlink C/N_o in dB-Hz
Guard List Size	4	0-15	Size of guard list, not including terminal node address
Guard List CRC	16		
Terminal Type	1	0 = Half-duplex at rf 1 = Full-duplex at rf	Allows the PCC to schedule adjacent transmit and receive time slots.
Silent Terminal Indicator	1	0 = No 1 = Yes	

TABLE C-XXV. ROW:Status Report message (Concluded).

FIELD	BITS	VALUE	NOTES
Terminal Standard Version	4	Compliant with 0 = MIL-STD-188-182 1 = MIL-STD-188-182A 2-15 = Reserved	Highest version of MIL-STD that the terminal complies with.
Automatic Frequency Change Capability	1	0 = No 1 = Yes	
Ranging Type	1	0 = Active 1 = Passive	
Retransmission Flag	1	0 = No retransmission difficulty 1 = Retransmission difficulty	
25-kHz Standard Version	3	0 = 25-kHz disabled 1 = MIL-STD-188-183 2 = MIL-STD-188-183A 3-7 = Reserved	
Total Size	60		

NOTES: A response to a request to report the network members status (FOW 26).

TABLE C-XXVI. ROW:Terminal Address Add or Delete Response message.

FIELD	BITS	VALUE	NOTES
Message Type	6	25	
Request Status	2	0 = Address added 1 = Address deleted 2 = Address add failure 3 = Address delete failure	
Address	16		Address to be added/deleted
Retransmission Flag	1	0 = No retransmission difficulty 1 = Retransmission difficulty	
Reserved Bits	35	0	All bits set to zero
Total Size	60		

NOTE: A response to a request to add or delete an address in a guard list (FOW 28).

TABLE C-XXVII. ROW:Terminal Address Report message.

FIELD	BITS	VALUE	NOTES
Message Type	6	26	
Guard List Index	3	0 = Reporting first three guard list addresses 1 = Reporting second three guard list addresses 2 = Reporting third three guard list addresses 3 = Reporting fourth three guard list addresses 4 = Reporting last three guard list addresses 5-7 = Reserved	Specifies which guard list addresses are being reported.
Address 0	16		First guard address being reported in this ROW message.
Address 1	16	0 = No reported address	Second guard address being reported in this ROW message.
Address 2	16	0 = No reported address	Third guard address being reported in this ROW message.
Retransmis-sion Flag	1	0 = No retransmission difficulty 1 = Retransmission difficulty	
Reserved Bits	2	0	All bits set to zero
Total Size	60		

NOTE: A response to a request to report the addresses in the guard list (FOW 27).

TABLE C-XXVIII. ROW:Terminal Channel Assignment Response message.

FIELD	BITS	VALUE	NOTES
Message Type	6	27	
Change Response	1	0 = Not moving to new channel 1 = Moving to new channel	
Retransmission Flag	1	0 = No retransmission difficulty 1 = Retransmission difficulty	
Reserved Bits	52	0	All bits set to zero
Total Size	60		

NOTE: A response to direction to move to a different channel (FOW 32).

TABLE C-XXIX. ROW:Terminal Channel Return message.

FIELD	BITS	VALUE	NOTES
Message Type	6	28	
Retry Flag	1	0 = First Attempt 1 = Retry	Indicates whether the particular ROW message is being sent the first time or as a second attempt (retry).
Reserved Bits	53	0	All bits set to zero
Total Size	60		

NOTE: Notification of return from a single access channel. The PCC responds with a FOW 30.

APPENDIX D

FREQUENCY PLANS

D.1 SCOPE

This Appendix is a mandatory part of this standard. The information contained herein is intended for compliance. The information contained herein provides the correlation between the channel frequency code and radio frequency (rf) of operation. The data defined herein is included in the FOW:Terminal Channel Assignment message to direct terminals to change to a different rf channel for communications. Each frequency switching capable terminal shall be able to interpret the Channel field of the FOW:Terminal Channel Assignment message and automatically switch to the frequency as specified in this appendix.

TABLE D-I. Current and UHF Follow-On frequency plans.
(This table will be used for the Channel Frequency fields.
See key at end of table.)

CHANNEL NUMBER DECIMAL	CHANNEL NUMBER HEX	UPLINK FREQUENCY (MHz)	DOWNLINK FREQUENCY (MHz)	PRESENT CHANNEL	UFO CHANNEL	NOTES
0	0	NONE	NONE	NONE	N/A	
1	1	SHF	250.350	W1	N1	Fleet broadcast
2	2	SHF	250.400		N'1	"
3	3	SHF	250.450	A1	O1	"
4	4	SHF	250.500		O'1	"
5	5	SHF	250.550	B1	P1	"
6	6	SHF	250.600		P'1	"
7	7	SHF	250.650	C1	Q1	"
8	8	SHF	250.700		Q'1	"
9	9	292.850	251.850	W3	N2	NAVY 25kHz CHANNELS, 41 MHz OFFSET
10	0A	292.950	251.950	A2	O2	"
11	0B	293.050	252.050	B2	P2	"
12	0C	293.150	252.150	C2	Q2	"
13	0D	294.550	253.550	W4	N3	"
14	0E	294.650	253.650	A3	O3	"
15	0F	294.750	253.750	B3	P3	"
16	10	294.850	253.850	C3	Q3	"
17	11	296.250	255.250	W5	N4	"
18	12	296.350	255.350	A4	O4	"
19	13	296.450	255.450	B4	P4	"
20	14	296.550	255.550	C4	Q4	NAVY 25kHz CHANNELS, 41 MHz OFFSET

TABLE D-I. Current and UHF Follow-On frequency plans (Continued).

CHANNEL NUMBER DECIMAL	CHANNEL NUMBER HEX	UPLINK FREQUENCY (MHz)	DOWNLINK FREQUENCY (MHz)	PRESENT CHANNEL	UFO CHANNEL	NOTES
21	15	297.850	256.850	W6	N5	"
22	16	297.950	256.950	A5	O5	"
23	17	298.050	257.050	B5	P5	"
24	18	298.150	257.150	C5	Q5	"
25	19	299.350	258.350	W7	N6	"
26	1A	299.450	258.450	A6	O6	"
27	1B	299.550	258.550	B6	P6	"
28	1C	299.650	258.650	C6	Q6	"
29	1D	306.250	265.250	W8	N7	"
30	1E	306.350	265.350	A7	O7	"
31	1F	306.450	265.450	B7	P7	"
32	20	306.550	265.550	C7	Q7	"
33	21	307.750	266.750	*	N8	"
34	22	307.850	266.850	A8	O8	"
35	23	307.950	266.950	B8	P8	"
36	24	308.050	267.050	C8	Q8	"
37	25	309.150	268.150		N9	"
38	26	309.250	268.250	A9	O9	"
39	27	309.350	268.350	B9	P9	"
40	28	309.450	268.450	C9	Q9	"
41	29	310.650	269.650		N10	"
42	2A	310.750	269.750	A10	O10	"
43	2B	310.850	269.850	B10	P10	"
44	2C	310.950	269.950	C10	Q10	NAVY 25kHz CHANNELS, 41 MHz OFFSET

* 307.750 was used as the Gapfiller channel A uplink frequency. 266.750 is not in correct use as a downlink frequency.

TABLE D-I. Current and UHF Follow-On frequency plans (Continued).

CHANNEL NUMBER		UPLINK FREQUENCY (MHz)	DOWNLINK FREQUENCY (MHz)	PRESENT CHANNEL	UFO CHANNEL	NOTES
DECIMAL	HEX					
45	2D	293.950	260.350	A23-1		DoD 500 kHz CHANNELS/ UFO 25kHz CHANNELS
46	2E	293.975	260.375	A23-2	N11	"
47	2F	294.000	260.400	A23-3		"
48	30	294.025	260.425	A23-4	P11	"
49	31	294.050	260.450	A23-5		"
50	32	294.075	260.475	A23-6	N12	"
51	33	294.100	260.500	A23-7		"
52	34	294.125	260.525	A23-8	P12	"
53	35	294.150	260.550	A23-9		"
54	36	294.175	260.575	A23-10	O11	"
55	37	294.200	260.600	A23-11		"
56	38	294.225	260.625	A23-12	Q11	"
57	39	294.250	260.650	A23-13		"
58	3A	294.275	260.675	A23-14	O12	"
59	3B	294.300	260.700	A23-15		"
60	3C	294.325	260.725	A23-16	Q12	"
61	3D	294.350	260.750	A23-17		"
62	3E	294.375	260.775	A23-18		"
63	3F	294.400	260.800	A23-19		"
64	40	294.425	260.825	A23-20		"
65	41	294.450	260.850	A23-21		"
66	42	295.050	261.450	B23-1		"

TABLE D-I. Current and UHF Follow-On frequency plans (Continued).

CHANNEL NUMBER DECIMAL	CHANNEL NUMBER HEX	UPLINK FREQUENCY (MHz)	DOWNLINK FREQUENCY (MHz)	PRESENT CHANNEL	UFO CHANNEL	NOTES
67	43	295.075	261.475	B23-2		DoD 500 kHz CHANNELS/ UFO 25kHz CHANNELS
68	44	295.100	261.500	B23-3		"
69	45	295.125	261.525	B23-4		"
70	46	295.150	261.550	B23-5		"
71	47	295.175	261.575	B23-6	N13	"
72	48	295.200	261.600	B23-7		"
73	49	295.225	261.625	B23-8	P13	"
74	4A	295.250	261.650	B23-9		"
75	4B	295.275	261.675	B23-10	N14	"
76	4C	295.300	261.700	B23-11		"
77	4D	295.325	261.725	B23-12	P14	"
78	4E	295.350	261.750	B23-13		"
79	4F	295.375	261.775	B23-14	N15	"
80	50	295.400	261.800	B23-15		"
81	51	295.425	261.825	B23-16	P15	"
82	52	295.450	261.850	B23-17		"
83	53	295.475	261.875	B23-18	N16	"
84	54	295.500	261.900	B23-19		"
85	55	295.525	261.925	B23-20	P16	"
86	56	295.550	261.950	B23-21		"
87	57	295.650	262.050	C23-1		"
88	58	295.675	262.075	C23-2	O13	"
89	59	295.700	262.100	C23-3		"
90	5A	295.725	262.125	C23-4	Q13	"

TABLE D-I. Current and UHF Follow-On frequency plans (Continued).

CHANNEL NUMBER		UPLINK FREQUENCY (MHz)	DOWNLINK FREQUENCY (MHz)	PRESENT CHANNEL	UFO CHANNEL	NOTES
DECIMAL	HEX					
91	5B	295.750	262.150	C23-5		"
92	5C	295.775	262.175	C23-6	O14	DoD 500 kHz CHANNELS/ UFO 25kHz CHANNELS
93	5D	295.800	262.200	C23-7		"
94	5E	295.825	262.225	C23-8	Q14	"
95	5F	295.850	262.250	C23-9		"
96	60	295.875	262.275	C23-10	O15	"
97	61	295.900	262.300	C23-11		"
98	62	295.925	262.325	C23-12	Q15	"
99	63	295.950	262.350	C23-13		"
100	64	295.975	262.375	C23-14	O16	"
101	65	296.000	262.400	C23-15		"
102	66	296.025	262.425	C23-16	Q16	"
103	67	296.050	262.450	C23-17		"
104	68	296.075	262.475	C23-18		"
105	69	296.100	262.500	C23-19		"
106	6A	296.125	262.525	C23-20		"
107	6B	296.150	262.550	C23-21		"
108	6C	297.150	263.550	W2-1		"
109	6D	297.175	263.575	W2-2	N17	"
110	6E	297.200	263.600	W2-3		"
111	6F	297.225	263.625	W2-4	P17	"
112	70	297.250	263.650	W2-5		"
113	71	297.275	263.675	W2-6	N18	"
114	72	297.300	263.700	W2-7		"

TABLE D-I. Current and UHF Follow-On frequency plans (Continued).

CHANNEL NUMBER DECIMAL	CHANNEL NUMBER HEX	UPLINK FREQUENCY (MHz)	DOWNLINK FREQUENCY (MHz)	PRESENT CHANNEL	UFO CHANNEL	NOTES
115	73	297.325	263.725	W2-8	P18	"
116	74	297.350	263.750	W2-9		"
117	75	297.375	263.775	W2-10	O17	DoD 500 kHz CHANNELS/ UFO 25kHz CHANNELS
118	76	297.400	263.800	W2-11		
119	77	297.425	263.825	W2-12	Q17	"
120	78	297.450	263.850	W2-13		"
121	79	297.475	263.875	W2-14	O18	"
122	7A	297.500	263.900	W2-15		"
123	7B	297.525	263.925	W2-16	Q18	"
124	7C	297.550	263.950	W2-17		"
125	7D	297.575	263.975	W2-18		"
126	7E	297.600	264.000	W2-19		"
127	7F	297.625	264.025	W2-20		"
128	80	297.650	264.050	W2-21		"
129	81	302.445	248.845		N27	GAPFILLER 500 kHz CHANNELS/ UFO 5 kHz CHANNELS
130	82	302.450	248.850	G1		"
131	83	302.455	248.855		N28	"
132	84	302.465	248.865		N29	"
133	85	302.475	248.875	G2	N30	"
134	86	302.485	248.885		N31	"
135	87	302.495	248.895		N32	"
136	88	302.500	248.900	G3		"

TABLE D-I. Current and UHF Follow-On frequency plans (Continued).

CHANNEL NUMBER		UPLINK FREQUENCY (MHz)	DOWNLINK FREQUENCY (MHz)	PRESENT CHANNEL	UFO CHANNEL	NOTES
DECIMAL	HEX					
137	89	302.505	248.905		N33	"
138	8A	302.515	248.915		N34	"
139	8B	302.525	248.925	G4	N35	"
140	8C	302.535	248.935		N36	GAPFILLER 500 kHz CHANNELS/ UFO 5 kHz CHANNELS
141	8D	302.545	248.945		N37	"
142	8E	302.550	248.950	G5		"
143	8F	302.555	248.955		N38	"
144	90	302.565	248.965		N39	"
145	91	302.575	248.975	G6	O27	"
146	92	302.585	248.985		O28	"
147	93	302.595	248.995		O29	"
148	94	302.600	249.000	G7		"
149	95	302.605	249.005		O30	"
150	96	302.615	249.015		O31	"
151	97	302.625	249.025	G8	O32	"
152	98	302.635	249.035		O33	"
153	99	302.645	249.045		O34	"
154	9A	302.650	249.050	G9		"
155	9B	302.655	249.055		O35	"
156	9C	302.665	249.065		O36	"
157	9D	302.675	249.075	G10	O37	"
158	9E	302.685	249.085		O38	"
159	9F	302.695	249.095		O39	"
160	A0	302.700	249.100	G11		"

TABLE D-I. Current and UHF Follow-On frequency plans (Continued).

CHANNEL NUMBER		UPLINK FREQUENCY (MHz)	DOWNLINK FREQUENCY (MHz)	PRESENT CHANNEL	UFO CHANNEL	NOTES
DECIMAL	HEX					
161	A1	302.705	249.105		P27	"
162	A2	302.715	249.115		P28	"
163	A3	302.725	249.125	G12	P29	"
164	A4	302.735	249.135		P30	"
165	A5	302.745	249.145		P31	GAPFILLER 500 kHz CHANNELS/ UFO 5 kHz CHANNELS
166	A6	302.750	249.150	G13		"
167	A7	302.755	249.155		P32	"
168	A8	302.765	249.165		P33	"
169	A9	302.775	249.175	G14	P34	"
170	AA	302.785	249.185		P35	"
171	AB	302.795	249.195		P36	"
172	AC	302.800	249.200	G15		"
173	AD	302.805	249.205		P37	"
174	AE	302.815	249.215		P38	"
175	AF	302.825	249.225	G16	P39	"
176	B0	302.835	249.235		Q27	"
177	B1	302.845	249.245		Q28	"
178	B2	302.850	249.250	G17		"
179	B3	302.855	249.255		Q29	"
180	B4	302.865	249.265		Q30	"
181	B5	302.875	249.275	G18	Q31	"
182	B6	302.885	249.285		Q32	"
183	B7	302.895	249.295		Q33	"
184	B8	302.900	249.300	G19		"

TABLE D-I. Current and UHF Follow-On frequency plans (Continued).

CHANNEL NUMBER DECIMAL	CHANNEL NUMBER HEX	UPLINK FREQUENCY (MHz)	DOWNLINK FREQUENCY (MHz)	PRESENT CHANNEL	UFO CHANNEL	NOTES
185	B9	302.905	249.305		Q34	"
186	BA	302.915	249.315		Q35	"
187	BB	302.925	249.325	G20	Q36	"
188	BC	302.935	249.335		Q37	"
189	BD	302.945	249.345		Q38	"
190	BE	302.950	249.350			GAPFILLER 500 kHz CHANNELS/ UFO 5 kHz CHANNELS
191	BF	302.955	249.355		Q39	"
192	CO	307.750	254.150	GA		GAPFILLER 25 kHz (UFO CHAN N8 UPLINK)
193	C1	311.150	257.550	GB		GAPFILLER 25 kHz
194	C2	316.955	243.855	W9		AFSAT/ LEASAT NON-PROC. 5 kHz REPLACE-MENT CHANNELS
195	C3	316.960	243.860	W10		"
196	C4	316.975	243.875	W11		"
197	C5	317.000	243.900	W12		"
198	C6	317.010	243.910	W13		"
199	C7	317.015	243.915		N19	"
200	C8	317.025	243.925		N20	"
201	C9	317.035	243.935		N21	"
202	CA	317.045	243.945	A11	N22	"

TABLE D-I. Current and UHF Follow-On frequency plans (Continued).

CHANNEL NUMBER DECIMAL	CHANNEL NUMBER HEX	UPLINK FREQUENCY (MHz)	DOWNLINK FREQUENCY (MHz)	PRESENT CHANNEL	UFO CHANNEL	NOTES
203	CB	317.055	243.955	A12	N23	"
204	CC	317.065	243.965	A14	N24	"
205	CD	317.075	243.975	A16	N25	"
206	CE	317.085	243.985	A18	N26	"
207	CF	317.090	243.990	A19		"
208	DO	317.095	243.995	A20	O19	"
209	D1	317.100	244.000	A21		AFSAT/ LEASAT NON-PROC. 5 kHz REPLACE-MENT CHANNELS
210	D2	317.105	244.005		O20	"
211	D3	317.110	244.010	A22		"
212	D4	317.115	244.015		O21	"
213	D5	317.125	244.025		O22	"
214	D6	317.135	244.035		O23	"
215	D7	317.145	244.045	B11	O24	"
216	D8	317.155	244.055	B12	O25	"
217	D9	317.165	244.065	B14	O26	"
218	DA	317.175	244.075	B16	P19	"
219	DB	317.185	244.085	B18	P20	"
220	DC	317.190	244.090	B19		"
221	DD	317.195	244.095	B20	P21	"
222	DE	317.200	244.100	B21		"
223	DF	317.205	244.105		P22	"
224	EO	317.210	244.110	B22		"
225	E1	317.215	244.115		P23	"

TABLE D-I. Current and UHF Follow-On frequency plans (Continued).

CHANNEL NUMBER DECIMAL	CHANNEL NUMBER HEX	UPLINK FREQUENCY (MHz)	DOWNLINK FREQUENCY (MHz)	PRESENT CHANNEL	UFO CHANNEL	NOTES
226	E2	317.225	244.125		P24	"
227	E3	317.235	244.135		P25	"
228	E4	317.245	244.145	C11	P26	"
229	E5	317.255	244.155	C12	Q19	"
230	E6	317.265	244.165	C14	Q20	"
231	E7	317.275	244.175	C16	Q21	"
232	E8	317.285	244.185	C18	Q22	"
233	E9	317.290	244.190	C19		AFSAT/ LEASAT NON-PROC. 5 kHz REPLACE-MENT CHANNELS
234	EA	317.295	244.195	C20	Q23	"
235	EB	317.300	244.200	C21		"
236	EC	317.305	244.205		Q24	"
237	ED	317.310	244.210	C22		"
238	EE	317.315	244.215		Q25	"
239	EF	317.325	244.225		Q26	"
240	FO					
241	F1					
242	F2					
243	F3					
244	F4					
245	F5					
246	F6					
247	F7					
248	F8					

APPENDIX D

TABLE D-I. Current and UHF Follow-On frequency plans (Concluded).

CHANNEL NUMBER		UPLINK FREQUENCY (MHz)	DOWNLINK FREQUENCY (MHz)	PRESENT CHANNEL	UFO CHANNEL	NOTES
DECIMAL	HEX					
249	F9					
250	FA					
251	FB					
252	FC					
253	FD					
254	FE					
255	FF					

Key to channel numbers: There are several frequency plans used on UHF satellites for the DoD. The FLTSATCOM satellites use frequency plans *A*, *B*, and *C*. The Leased Satellites (LEASATs) use frequency plans *X*, *Y*, and *Z*, which are abbreviated versions of plans *A*, *B*, and *C* (LEASATs have fewer channels). In addition, LEASAT has plan W, which shares frequencies with AFSATCOM polar frequency plan *E*. Gapfiller has been labeled for this table as *G*. UHF Follow-On (UFO) uses four frequency plans, *N*, *O*, *P*, and *Q*. In addition, there are alternate Fleet Broadcast downlink frequencies labeled *N*', *O*', *P*', and *Q*'.

Table D-I lists *present Channel* and *UFO Channel* as follows: Frequency plan, transponder number, and an optional transponder subdivision. As an example, Channel Number 46 (Hex 2E) is A23-2. This corresponds to FLTSATCOM frequency plan *A*, a DoD 500 kHz wideband channel (used as a 25 kHz sub-channel) which is being replaced by UFO 25 kHz channel N11 (frequency plan *N*, transponder 11).

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CONCLUDING MATERIAL

Custodians:

Army - CR
Navy - EC
Air Force - 90

Preparing Activity:

DISA - DC1
(Project TCSS-1821)

Review Activities:

Army - AC, IQ, IR, SC, PT
Navy - CG, MC, OM, NC, TD
Air Force - 02, 13, 17, 21, 29, 33, 93
DLA - DH
NSA - NS
DMA - MP

Civil Agency Coordinating Activities:

DOT - OST

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.

2. The submitter of this form must complete blocks 4, 5, 6, and 7.

3. The preparing activity must provide a reply within 30 days from receipt of the form.

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I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER: **MIL-STD-188-182A**	2. DOCUMENT DATE (YYMMDD) **970331**

3. DOCUMENT TITLE: **Interoperability Standard for 5-kHz UHF DAMA Terminal Waveform**

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME *(Last, First, Middle Initial)*	b. ORGANIZATION	
c. ADDRESS *(Include Zip Code)*	d. TELEPHONE *(Include Area Code)* (1) Commercial (2) AUTOVON *(if applicable)*	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

a. NAME: **Joint Interoperability and Engineering Organization (JIEO)**	b. TELEPHONE *(Include Area Code)* (1) Commercial: **(908) 427-6865** (2) AUTOVON: **987-6865**
c. ADDRESS *(Include Zip Code)* **ATTN: JEBBC** **Fort Monmouth, NJ 07703-5613**	**IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:** Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340